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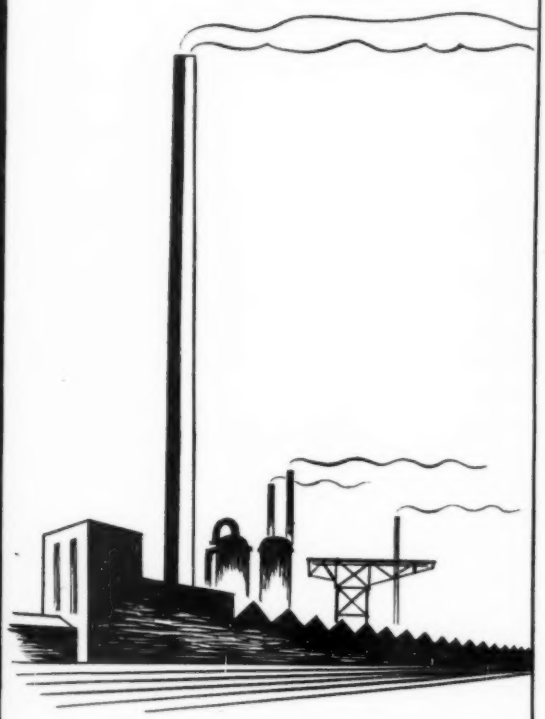

FOR BRITISH INDUSTRY

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INCORPORATING THE METALLURGICAL ENGINEER

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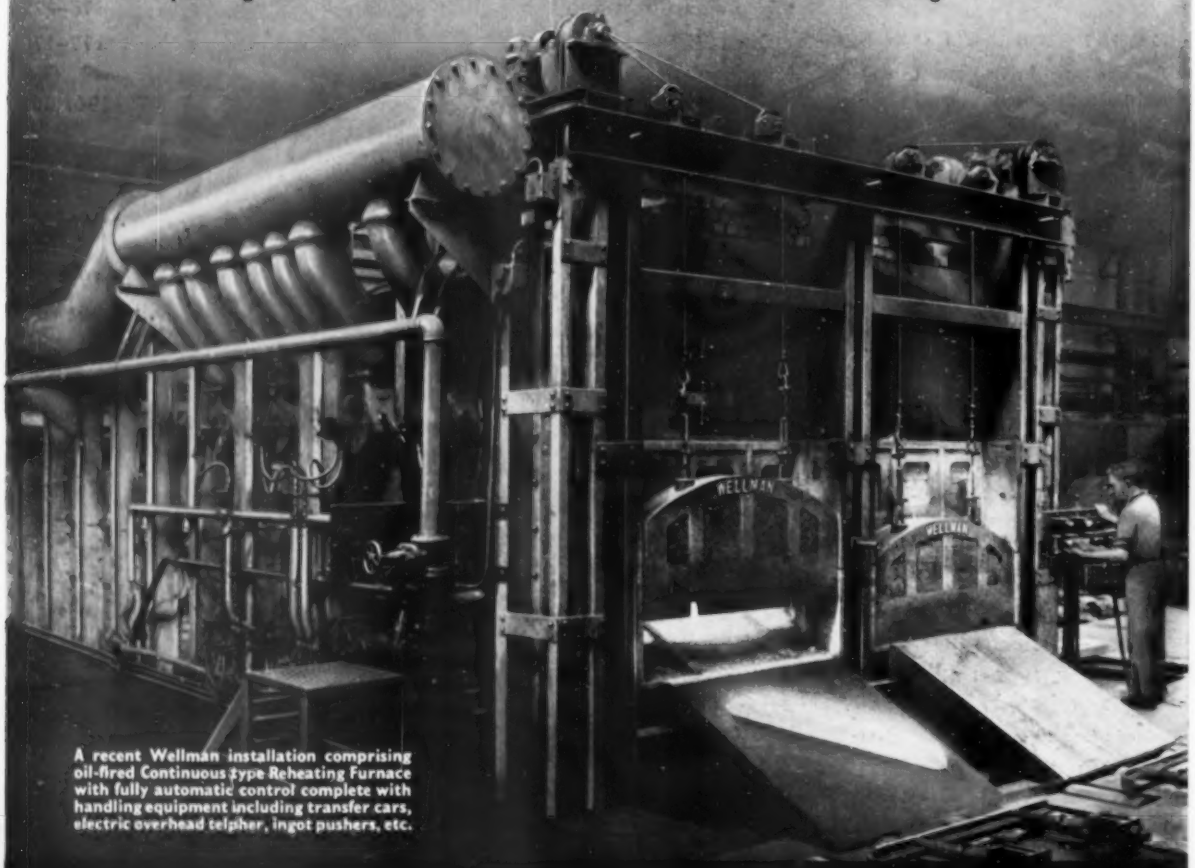

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METALLURGIA

THE BRITISH JOURNAL OF METALS

INCORPORATING THE "METALLURGICAL ENGINEER."

APRIL, 1952 Vol. XLV No. 270

The British Industries Fair

As the opening of the British Industries Fair approaches once again, the perennial discussions of its value will no doubt be revived. In so far as this year's Fair is concerned, the discussion is purely academic as the die is cast: the displays are decided, the stands are being prepared, and even now overseas buyers are on their way to attend. In point of fact the preliminary plans for the 1953 Fair will have been drawn up before this year's Fair opens, and in July potential exhibitors will be invited to reserve space for next year.

In view of the opposing views on the value of participating in this and other fairs, a study of the background of the B.I.F. might be worthwhile. In the first place, it is well that we should distinguish between exhibitions and fairs. The former are displays with very limited facilities for trading transactions other than minor retail sales, their primary object being to enhance prestige and goodwill, and to encourage designers, showmen and craftsmen. Fairs, on the other hand, are—apart from the carnival and amusement variety—displays of products, with the object of selling goods retail to the general public on the spot, or of interesting trade buyers in samples shown with a view to attracting orders for goods to be delivered later from the factories and warehouses. Large trade fairs are usually held once or twice a year, and may be national, such as the B.I.F., or international in character. Three other national trade fairs comparable with the B.I.F. are the Swiss Industries Fair, which is held each spring at Basle, the Comptoir Suisse in Lausanne each autumn, and the Svenska Massan (Swedish National Fair) held at Gothenburg.

Forerunners of modern trade fairs were the markets of ancient times, at which merchants came together periodically to display spices, skins, incense, precious stones and rich cloth. With the growth of centres of population, and with improvements in transport, those early markets grew in size. They differed in character from modern trade fairs in that goods to be sold, and not mere samples, were on view, the buyers being the general public rather than trade buyers. It is interesting to note that one of the early fairs in this country, which had its charter from King John in 1211, was held at Stourbridge, which is not so very far from the B.I.F.'s Midlands home at Castle Bromwich. The industrial revolution and modern facilities for speedy communication killed most of the old trade fairs, though a few continue to flourish. Two of the most famous, Nijni-Novgorod and Leipzig are but shadows of their former selves.

While its famous predecessors have declined, the B.I.F. has grown from strength to strength. Originally held in 1915, to show the progress manufacturers had made towards the production of certain classes of goods for which the country had previously been dependent on Austria and Germany, the floor space has been increased from the 90,000 sq. ft. on that occasion to the neighbourhood of 1,000,000 sq. ft. this year. The Castle Bromwich Section of the Fair, housing the heavy industries and hardware, was first held in 1920 in an aeroplane hangar purchased by the Birmingham Chamber of Commerce, and apart from a break during the war has been held there ever since. This year it will have 1,300 exhibitors in a building which is 1,885 ft. long × 470 ft. wide, together with an outdoor section of 3 acres.

The main object of the Fair, and this cannot be too strongly emphasised in considering its worth, is the advancement of the export trade. It is fitting, therefore, that the organisation should be in the hands of the Commercial Relations and Export Department of the Board of Trade, in close collaboration with the Birmingham Chamber of Commerce, which is responsible for the administration of the Castle Bromwich Section. Publicity for both London and Birmingham is carried out by the Information Division of the Board of Trade, and as it is essential to secure the maximum attendance of trade buyers from all countries of the world, an intensive campaign is undertaken. This publicity has to start early in order to influence buyers in the most distant countries in time for them to make their reservations for travel and hotel accommodation. Apart from 1,000 advertisements in the press of 60 countries, 85,000 posters, and 550,000 information booklets (in nine languages), a series of direct mail letters, enclosing invitations to the Fair, is sent to 130,000 overseas buyers. In addition, special campaigns are being carried out in the U.S.A. and Canada with the help of advertising specialists in those countries. Having persuaded the overseas buyer to make the trip, no effort is spared to make his visit worthwhile. At each site, there is a club specially appointed for his comfort and convenience, where he can obtain secretarial and stenographic services, interpreter service and telephone and cable facilities. Nor are his social requirements neglected; seats can be booked at theatres and sporting events, or arrangements made for tours of the countryside.

How successful are these efforts? In 1937–39, the average annual attendance of overseas buyers was 5,000, in the years 1947–49 it had risen to 16,000, whilst in 1950 and 1951 it exceeded 19,000. In addition a total of 99,455 home buyers and 68,699 members of the general public visited the 1951 Fair. Of the overseas buyers, about a thousand came from the United States and of these, 4% came solely to attend the B.I.F., 72% combined the Fair with other business, 41% coupled it with pleasure, and 13% with other trade fairs.

Such fairs as the B.I.F. have many economic advantages both for the countries providing the goods, and for those whose buyers attend. The Fair presents a range of products assembled in one place at one time such as a buyer could usually see only in an extensive, expensive

and time-consuming tour. The total value of the goods sold is never ascertainable, as orders may not be signed for months afterwards, but the best evidence that big business is done is the continued support of exhibitors, and it can be safely inferred that a great number of buyers would not travel so far to place only small orders. When orders are placed, they mean increased wealth for the seller country and desirable goods for the buyer country. In Britain's case, the B.I.F. is particularly valuable as a dollar earner. The U.S.A. wants to buy the quality goods which Britain produces; she can afford them, and the more she buys the more able Britain becomes to import the goods of which the U.S.A. has a surplus. Moreover, contacts between buyer and manufacturer help each to understand the other's problems. They encourage new designs and adaptations, trade relations, international friendship, and exchanges of ideas. Finally, a large and successful Fair confers prestige on the country in which it is held, on its organisers, and on the firms which exhibit.

New Alloys Aid Gas Turbine Performance

BRITAIN'S lead over other countries in gas turbine design has imposed upon metallurgists the need to produce materials with increasingly good properties at high temperatures. From the early days of the gas turbine engine, the Nimonic series of nickel-chromium alloys have become established as the standard materials for the rotor blades of every British aircraft gas turbine in production. To increase efficiency, designers have been continually pressing for improved alloys which would give the required strength at ever increasing temperatures. When rotors are turning at speeds in excess of 10,000 r.p.m. and at temperatures substantially exceeding 800° C., the requirements of materials for the rotor blades are severe in the extreme. But in addition these materials, though giving the required strength and resistance to creep at high temperatures, must be capable of hot-working and machining.

The Birmingham Research Laboratories of The Mond Nickel Co., Ltd., which early in the war years produced Nimonic, the nickel-chromium alloy which really turned the gas turbine from an expensive prototype to a production power unit, have now announced a new advance. Ever since the development of the earliest Nimonic alloys for rotor blades, work has been progressing steadily towards the provision of improved alloys, having better stress properties at increasing temperatures. After more than twelve years the Nimonic series of alloys remains the outstanding material for the rotor blades of aircraft gas turbines.

The latest achievement is the development of Nimonic 95. This alloy, which can only now be mentioned for the first time, has been developed from Nimonic 90, already well proved as the standard material for the moving blades of the best gas turbines available to-day. It is the result of intensive research which has continued for more than twelve years in an effort to improve the high-temperature properties of the nickel-chromium alloys without sacrificing forgeability at the expense of high-temperature strength. Improved methods of manufacture and processing have been adopted so that, although this new material is stronger and stiffer than Nimonic 90, it can still be hot-worked and machined.

The new material, which is already in production in the works of Henry Wiggin and Co., Ltd., and will soon be available in quantity, is the same type of alloy as Nimonic 90, but has an increased content of hardening elements. It provides the same level of strength as Nimonic 90, but at operating temperatures some 50° C. higher than those at which Nimonic 90 is used.

Dismantling the Dome of Discovery

THE dismantling of the Dome of Discovery and ten other buildings at the Festival of Britain site has been entrusted to George Cohen, Sons & Co., Ltd., who have a wide experience of dismantling work of every kind. In the course of their normal activities they have demolished many famous exhibition structures: outstanding among them were the Great Wheel at Earl's Court, which stood over 300 ft. high; many other buildings at Earl's Court; the "Flip-Flap" at the White City; the Tower of Empire at the Glasgow Exhibition and the Crystal Palace Towers.

Operations of this kind naturally require a high degree of specialised engineering experience and ingenuity. Nevertheless, and in spite of the unique nature of the Dome, it is regarded by them as substantially the equivalent of a large gas-holder and George Cohen's have dealt with many hundreds of these in the last 118 years. Jones KL Mobile Cranes with specially long jibs will be used on the job. These cranes, hundreds of which are being exported and operated all over the globe, are manufactured by K. & L. Steelfounders & Engineers, Ltd., of Letchworth—themselves members of The 600 Group, of which George Cohen, Sons & Co., Ltd., is the parent concern.

Alluvial Tin Ore in British Honduras

A RECONNAISSANCE geological survey of British Honduras was made by Mr. Leslie H. Ower, D.I.C., F.G.S., F.R.G.S., in 1925–1928, and his report published by the Royal Geographical Society (undated) announced the presence of small quantities of alluvial tin ore in various localities. In one of them, North Stann Creek, this has been confirmed in 1951 by the work of Mr. C. G. Dixon, B.Sc., F.G.S., Senior Geologist of the British Guiana Geological Survey, who has found that cassiterite seems to be fairly generally distributed throughout that valley and that traces occur also in tributaries of Sibun River and Freshwater Creek.

Pits were dug by pick and shovel, the gravels being washed by hand in a prospecting pan, and it was seldom possible to excavate to a depth greater than four feet. No estimate has been made of the depth of the alluvium, and the examination was merely of a preliminary exploratory character in which no quantitative estimates were possible. More detailed prospecting would require pumping, drilling, or other mechanical equipment. A second examination is being made this year when it is hoped to determine whether large-scale prospecting will be worth while.

Glacier Metal Acquisition

THE Glacier Metal Co., Ltd., has acquired, as from December 31st, 1951, the capital of Scottish Precision Castings, Ltd., Hillington Estate, Glasgow, manufacturers of aluminium and brass die castings. Scottish Precision Castings, Ltd., will keep its name and identity.

A Note on the Mechanism of Solidification of Horizontal Sand Castings

By K. C. Adamson, B.Sc., D.I.C., and J. B. Sayers, B.Sc., D.I.C.

The solidification of sand castings in aluminium and aluminium-zinc alloys has been studied by temperature measurements, pour-out tests and examination of macro-structures, and it is concluded that the macro-structure of the type of casting examined is mainly dependent on the difference in specific gravity between the primary crystallites and the liquid melt.

IN the past, investigations on macro-structures have been centred upon sand and chill cast ingots for subsequent fabrication. Satisfactory explanations have been advanced to account for the structures obtained, together with other observed phenomena such as segregation.[1] Little fundamental work has been done on the structures obtained in normal sand castings and difficulties which have arisen in practice in regard to macro-structure have been overcome by the use of chills, padding, risers and other ingenious devices.

The present work arose out of an investigation carried out by Dr. West[2] at the Royal School of Mines on the mechanism of solidification of steel castings. His results, relative to this paper, may be summarised as follows :

(1) Solidification takes place by the usual mechanism of skin formation, and the thickening of this skin on further heat extraction. The fundamental equation governing the rate of solidification is :—

$$D = k\sqrt{t} + c$$

where D is the thickness of skin solidified after a time t, and k and c are both constants, the value of c being in some way dependent on the super-heat of the melt.

(2) The main factor affecting the macro-structures of the castings is the distribution of centres of crystallisation during solidification and its relation to the rate of solidification. The distribution of these centres of crystallisation is markedly affected by the gravity settling of crystallites due to solidification contraction and, to a lesser extent, by the temperature conditions in the mould during solidification.

The object of the present investigation was to study the mechanism of solidification of a series of aluminium-base alloys solidifying as solid solutions. The results of such investigation, when correlated with the ferrous investigation mentioned above, would cover the normal temperature range encountered in practice. Any conclusion found to hold for both investigations would, in all probability, be found to apply to all sand castings solidifying as solid solutions.

Aluminium-zinc alloys were chosen for this investigation as the equilibrium diagram for these alloys shows that they solidify as solid solutions for a relatively wide range of zinc content, and from calculations[3] it was found that on increasing the zinc content the difference in specific gravity between the "crystallites" first deposited and the liquid melt decreased, and eventually reversed in sign.

There are three ways of tackling such a problem practically :—

(1) By taking temperature measurements [2, 4-10] in the mould and mould cavity during solidification. With this method it is possible to follow the solidification of the casting from start to finish. In conjunction with an examination of the macro-structure of the castings, this is probably the best method of approach and has been widely applied in the past.

(2) By the pour-out technique.[11-15] In this method the casting is bled a controlled time after the start of pouring and the resulting skin thickness determined. It is only possible to follow the earlier stages of solidification in this way. The exact significance of the results in relation to the liquidus-solidus range is difficult to assess ; this is particularly so in the case of alloys solidifying with a wide solidification range, as a considerable amount of pasty material is bound to be present at the time of pour-out. For this reason the method is usually used in conjunction with either (1) or (3).

(3) By the use of an electrical analogue.[16, 17] This is, in effect, an electrical calculating machine based upon the analogy between the heat flow in a heat exchange system, and the flow of electricity in a suitably designed circuit. The accuracy of the results obtained is dependent on a knowledge of certain physical constants of metals and moulding sands at elevated temperatures. As much of this data is not accurately known, the results are open to criticism, and in the past the results obtained in this way have often disagreed with those obtained by direct methods.

Complementary to these methods, there is the theoretical approach by means of a system of mathematical analysis,[18-22] but in order to evolve a workable equation many assumptions and simplifications have to be made. In practice these assumptions have not been borne out, and this has been particularly so in the case of alloys having a wide freezing range. The most significant result obtained from this line of approach is that :—

$$x = q\sqrt{t}$$

where x is the thickness of metal solidified in a time t.

In the present investigation it was hoped to use the method of taking temperature measurements in the mould and mould cavity during solidification in conjunction with the "pour-out" technique. The results would then be correlated with the observed macro-structures, and with the calculated difference in specific gravity between the first deposited crystallites and the liquid melt from which these crystallites had been deposited.

When considering an investigation of this nature it should be borne in mind that the main problem encountered is how to determine the behaviour of the

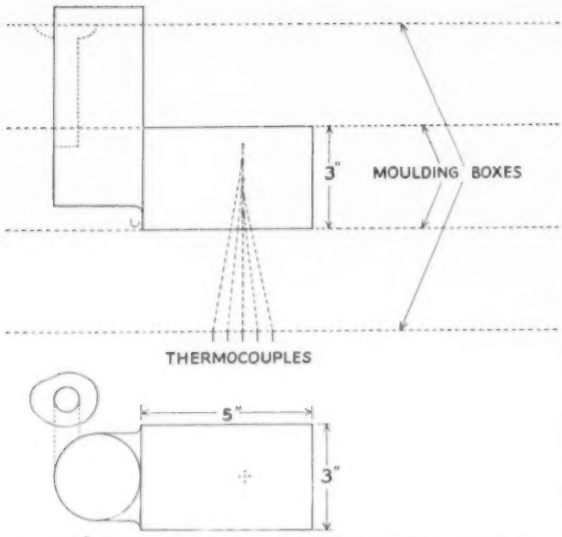


Fig. 1.—Mould assembly and location of thermocouples.

casting between the reaching of the liquidus temperature, when solidification or nucleation probably begins, and the passing of the solidus temperature when solidification is presumably complete.

Apparatus

The experimental castings consisted of horizontal blocks 5 in. long and 3 in. square cross-section, together with a whirl-gate feeder head with a volume approximately two-thirds that of the block. They were cast into skin-dried red Mansfield sand moulds, the moulds being made in three sections so that there was at least 2 in. of sand between the moulding boxes and any block face (see Fig. 1). The thermocouples were inserted through the base of the mould and fixed in position with core-gum before skin drying. It will be noticed that the couples were arranged in a conical manner. By this method it was possible to have all the couples approximately on the same vertical line and also any projected distance into the block. The couples were enclosed in twin-bore silica quills, and their hot junctions, which projected from the quills, were protected by a thin coating of alundum cement.

In some castings, where excessive piping occurred, it was found necessary to enlarge the head and remove the step of the whirl-gate in order to obtain a satisfactory casting.

The thermocouple readings were recorded automatically and a time/temperature graph subsequently constructed for each thermocouple. The instrument[2, 23] used for recording these readings consisted of a relay-operated selector switch (enabling up to 18 thermocouples to be used), a D.C. amplifier having a straight line characteristic, and a high-speed, variable-range recording milliammeter. This was used in conjunction with a known, variable back E.M.F., so as to provide high sensitivity in any given temperature range.

In each casting, one thermocouple was connected to a manually operated potentiometer and an "inverse rate" curve was constructed from the readings so obtained. This couple was usually placed adjacent to a thermocouple connected to the recording instrument. The "inverse rate" curves were helpful in checking the accuracy of the recorder and in interpreting the automatically recorded curves.

Experimental Work

Castings were made from commercial and super-purity aluminium; also a series of castings of both these with high purity zinc—up to 35% zinc with super-purity aluminium and 25% with the commercial purity aluminium. The alloys were melted in a gas-fired furnace and de-gassed by pre-solidification.

The mechanism of solidification was studied by taking temperature readings in the mould cavity and in the mould during solidification, by a series of pour-out castings of commercial purity aluminium, and by examining the macro-structure of the castings.

A transverse section was taken 3 in. from the end and the section examined by macro-etching, the etchants used being given in Table I. All castings were analysed for zinc content using the formic acid, controlled *p*H method. Owing to the necessity of having a large sample—0·5 g. to 2 g., depending on zinc content—and the provision of duplicate assays, it was found impossible to study segregation effects.

TABLE I.—MACRO-ETCHING REAGENTS USED

Estimated Composition of Castings	Zinc % (by analysis)	Etch Used
Aluminium	—	1
Aluminium*	—	2 or 3
Aluminium-5% Zinc	5·2	2
Aluminium-15% Zinc	15·5	3
Aluminium-25% Zinc	24·3	3
Aluminium-35% Zinc	33·8	3

* 99·5% aluminium. Aluminium in all other cases refers to the 99·99% aluminium.

COMPOSITION OF ETCHING REAGENTS

1. (Due to Hume-Rothery) copper sulphate dissolved in water, and hydrochloric acid added until cuprous chloride is formed.

2.			3.	
Hydrochloric acid ..	45 ml.		Hydrochloric acid ..	20 ml.
Nitric acid	15 ml.		Nitric acid	20 ml.
Hydrofluoric acid.. ..	15 ml.		Hydrofluoric acid ..	5 drops
Water	25 ml.		Water	60 ml.

Results

The results are presented under the following headings: Macro-structure; Temperature Measurements; and Pour-out Experiments.

Macro-structure

The results obtained from the commercial and super-purity aluminium, and the series of aluminium-zinc castings may be summarised as follows:

(*a*) The super-purity aluminium castings gave a very coarse radial columnar structure (Fig. 2).

(*b*) The commercial purity aluminium gave a similar structure, except that the columnar structure was somewhat refined and a small layer of equi-axial crystals was detected at the bottom of the casting (Fig. 3).

(*c*) On alloying the super and commercial purity aluminium with high purity zinc and gradually increasing the freezing range by increasing the zinc content, it was found that the layer of equi-axial crystals detected at the bottom of the 99·5% aluminium casting became deeper, eventually completely suppressing the columnar zone, giving a casting having an equi-axial type structure from top to bottom. As the depth of the equi-axial zone increased, the crystals at the bottom of the zone became coarser than those at the columnar/equi-axial interface. On increasing the freezing range beyond the point where the columnar-type structure was suppressed, this

Fig. 2.—Macro-structure of 99·99% aluminium casting.

Fig. 3.—Macro-structure of 99·5% aluminium casting.

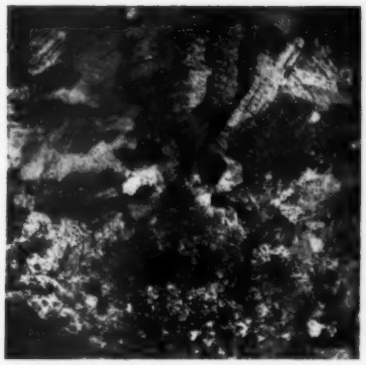


Fig. 4.—Macro-structure of 5% zinc casting made with 99·99% aluminium base.

coarsening became more marked and eventually columnar growth began from the lower surface. The structure obtained with dilute solid solutions of small freezing range was thus reversed. In the series of alloys made from super-purity aluminium, the upper columnar crystals were suppressed around 30% zinc, and columnar growth from the bottom was evident in the 35% zinc alloy. In those made from commercial purity aluminium, the columnars were suppressed around 16% zinc and columnar growth from the bottom was evident in the 20% zinc alloy—see Figs. 4–7.

From consideration of this evidence, solidification is thought to take place in the following manner. With a casting made from super-purity aluminium, solidification probably begins by the formation of crystallites around the walls of the casting and proceeds by the subsequent growth of such crystallites to form a coarse radial columnar structure. As little undercooling was indicated by the thermocouples, the number of crystallites would be correspondingly small and thus account for the coarse structure obtained. With commercial purity aluminium, some impurity, perhaps titanium, produces early formation of aluminium crystallites in the interior of the melt. As these are denser than the liquid melt—see Fig. 8—they will tend to sink to the bottom of the casting, and result in a thin layer of equi-axial crystals in that region.

On alloying with zinc, the casting solidifies over a range of temperature. The first deposited crystallites are of greater specific gravity than the liquid melt and will thus tend to sink. As in the case of a casting made from commercial purity aluminium, the crystallites result in a layer of equi-axial crystals at the bottom of the casting. The upper regions of the casting solidify by the formation of crystallites around the walls of the casting, the subsequent growth of such crystallites towards the centre of the casting forming a radial columnar structure.

On increasing the percentage of zinc in the melt, the freezing range is increased, and the difference between the specific gravity of the primary crystallites and the liquid metal decreases, and eventually the primary crystallites become less dense than the liquid melt. The reversal in sign of the specific gravity difference between the first deposited metal and the liquid melt is thought to be due to the balancing of an increase in specific gravity due to solidification contraction, by a decrease of specific gravity resulting from the increasing compositional difference between deposited metal and the liquid melt. This latter effect arises from the widening of the liquidus-solidus loop on increasing the zinc content.

The difference in specific gravity between the first deposited metal and the liquid melt as calculated from Stott's work on the aluminium-zinc system[3] is presented graphically in Fig. 8. This diagram represents the

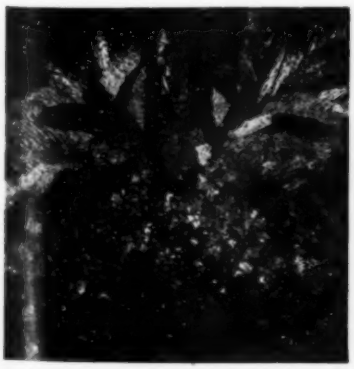


Fig. 5.—Macro-structure of 15% zinc casting made with 99·99% aluminium base.

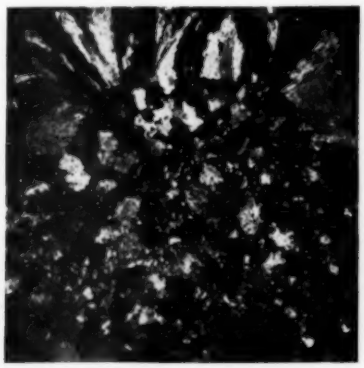


Fig. 6.—Macro-structure of 25% zinc casting made with 99·99% aluminium base.

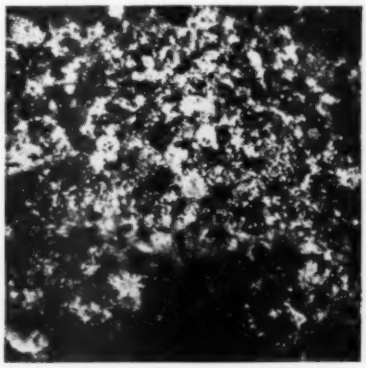


Fig. 7.—Macro-structure of 35% zinc casting made with 99·99% aluminium base.

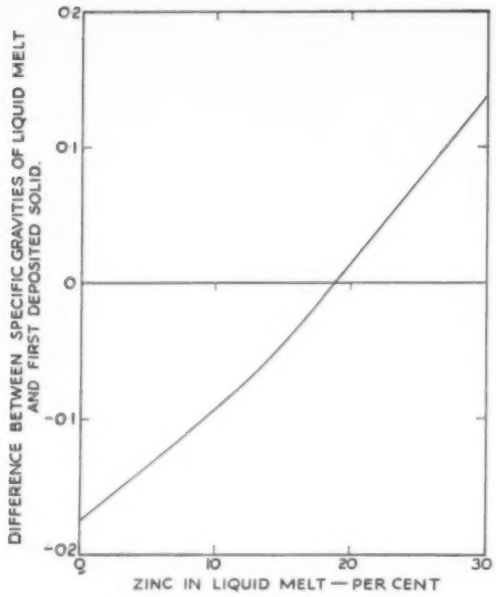


Fig. 8.—Relationship between zinc content and the difference in specific gravity between the liquid melt and the first deposited solid.

worst possible non-equilibrium condition that can occur, and it is for this reason that the structure does not reverse at 18% zinc. The specific gravity relationship between the growing crystallites and the melt will alter as a result of the changing composition of both the crystallites and the remaining liquid metal. Complete equilibrium will not occur as the growing crystallites will either tend to rise or sink, according to the difference in specific gravity between the crystallites and the remaining liquid metal. The remaining liquid will continue to solidify either by the growth of crystallites formed around the walls of the casting, or by the formation of fresh crystallites within the casting. It is thought that with dilute solid solutions, and correspondingly narrow freezing ranges, there is a tendency for the former mechanism to predominate, giving a radial columnar type structure, whilst with high zinc contents and longer freezing ranges, there is a tendency for the latter mechanism to predominate, giving an equi-axial type structure.

It is difficult to estimate the effect of crystallites formed in the later stages of solidification as, at this stage, the casting will be in a mushy condition. Any effects arising from the different specific gravities of the many growing crystallites will not exert the same influence on the final structure of the casting as would similar differences in the early stages of solidification, when the casting is in a more fluid condition.

This tendency for fresh crystallites to form within the casting with the widening of the liquidus-solidus loop tends to mask the actual zinc percentage at which the structure reverses. The increase in viscosity of the liquid melt with increasing zinc content may also be a significant factor in deciding the zinc percentage at which the structure reverses.

The sequence of structures obtained is thus mainly due to the specific gravity of the primary crystallites relative to that of the liquid melt, but is affected to a lesser extent by the specific gravity of subsequently deposited metal.

Temperature Measurements

The results obtained from this line of approach were very disappointing when compared with recent ferrous investigations[2] where this method has been found to be the most convenient and accurate means of following the progress of solidification of a casting until solidification is complete. Such results as were obtained may be summarised as follows :—

(1) After an initial time lag of approximately one minute, the temperatures indicated by the various thermocouples situated over the casting had fallen to the effective liquidus temperature. This phenomenon was apparently independent of the alloy content of the melt. The time lag of one minute is thought to be due to the super-heat of 50° C. which was the same for all castings. This corresponds very well with the time lag found by extrapolation of the results obtained from pour-out experiments. In connection with this observation it should be noted that the time necessary for pouring the melt was only 7–9 seconds.

(2) As solidification continued, the temperatures indicated by the various thermocouples fell slowly to the solidus temperature. After passing the solidus temperature, the temperatures dropped rapidly.

(3) At any stage during solidification, there was only a small scatter between the temperatures indicated by any of the thermocouples (Fig. 9). The working conditions of a thermocouple placed within the mould cavity are far from ideal and the temperature readings obtained show a larger experimental scatter than would be expected. For instance, couple 2 (Fig. 9) indicates a temperature approximately 3° C. below that indicated by couples 1, 3, 4 and 5. As couple 2 was placed between couples 1 and 3 this difference cannot be significant.

(4) Temperature readings were taken in the moulding sand during solidification of the casting. The temperatures reached at equivalent distances from the top and bottom sand/casting interfaces, appeared to be the same.

It was thus impossible to follow the progress of solidification across the casting by measuring the time for the temperature to reach the liquidus temperature and then the solidus temperature at various known points across the casting.

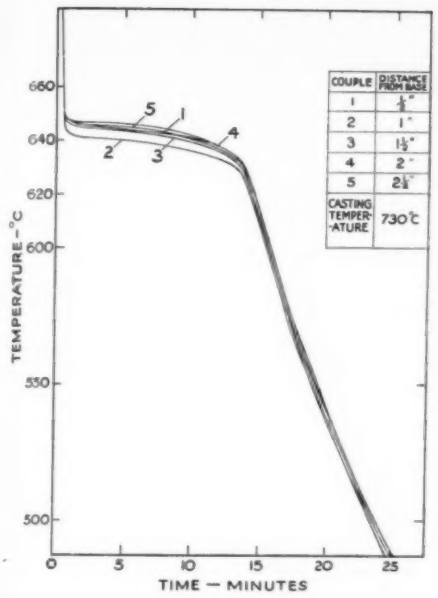
As it is highly improbable that no temperature gradient existed within the casting during solidification, it has been concluded that the temperature-gradient developed was within the experimental scatter of the temperatures indicated by the thermocouples. The smallness of the temperature gradient is thought to be due to the good thermal conductivity of aluminium and aluminium-zinc alloys in either the liquid or just solid state, as compared with the relatively poor thermal conductivity of the moulding sand.

Pour-out Experiments

A series of pour-out experiments were carried out on commercial purity aluminium castings by bleeding the castings a known time after the end of pouring. The results are shown graphically in Fig. 10. The following conclusions may be drawn from these results :—

(1) The equation governing the rate of solidification is parabolic in form :—

$$x = q\sqrt{t} + c$$



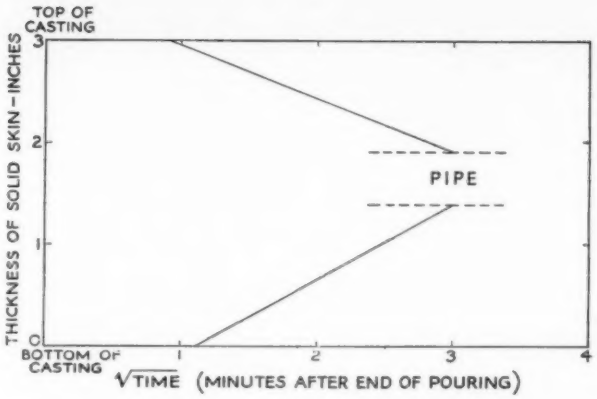


Fig. 9. (left)—Cooling curves for the solidification of a 5% zinc alloy made with 99·99% aluminium base.

Fig. 10. (right)—Relationship between skin thickness and time after pouring, as derived from pour-out tests on 99·5% aluminium.

Where x is the skin thickness of aluminium solidified in time t.

(2) By back-extrapolation of the curves there appeared to be a time lag of approximately one minute between the end of pouring, and the end of solidification at the sand/metal interface.

(3) Growth from the sides and bottom of the casting appeared to be very irregular, showing considerable corner effect, whilst that from the top was relatively regular (Fig. 11).

It was found impossible to carry out pour-out tests on aluminium-zinc alloys as the walls of such castings collapsed on bleeding. This was thought to be due to the weak nature of the alloys just below the solidus temperature, and to the small temperature gradient developed in the castings during solidification. Even if it had been found possible to carry out pour-out tests on aluminium-zinc alloys, the results obtained would have been difficult to interpret owing to the large amount of pasty metal which would have been present at the time of pour-out.

The solidification of a horizontal sand casting in commercial purity aluminium thus takes place by skin formation and the subsequent thickening of this skin. The solidification of castings made from dilute solid solution is thought to take place by a similar mechanism. On consideration of the negligible temperature gradients developed within the castings during solidification, it is thought that with alloys of wider freezing range, the mechanism of skin formation and subsequent thickening must in some way be modified, or possibly replaced by an entirely different mechanism essentially non-directional in character. As, however, no conclusive experimental evidence is available, no alternative mechanism can be suggested at present.

General Conclusions

(1) The macro-structure of the series of castings investigated was dependent mainly on the specific gravity of the primary crystallites relative to that of the liquid melt, and to a lesser extent upon the relative specific gravity of subsequently deposited metal.

(2) There appeared to be a time lag of approximately one minute between the end of pouring and the start of solidification.

(3) No temperature gradient could be detected within the casting at any stage during or after solidification. If such a gradient existed, it was within the experimental scatter of the temperatures indicated by the thermocouples.

(4) The temperatures reached within the moulding sand at equivalent distances from the top and bottom sand/casting interfaces appeared to be the same.

(5) The solidification of a horizontal sand-cast commercial purity aluminium block was found to be by skin formation and the subsequent thickening of this skin. The equation governing the rate of solidification was found to be parabolic in form :—

$$x = q\sqrt{t} + c$$

Where x is the skin thickness of aluminium solidified in a time t.

Fig. 11.—Cross-section of casting bled 7 minutes after pouring was completed.

(6) The solidification of dilute solid solutions is thought to take place by a similar mechanism. With alloys of wider freezing range, it is thought that this mechanism must in some way be modified or possibly replaced by a different mechanism essentially non-directional in character. As, however, no conclusive experimental evidence is available, no alternative mechanism can at present be formulated.

Acknowledgments

The authors wish to thank Asst. Prof. M. S. Fisher for his interest and advice throughout the course of the work, Prof. C. W. Dannatt for his permission to use the facilities in the Metallurgy Department at the Royal School of Mines, and also the academic and laboratory staff for their kind co-operation.

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Correspondence

Magnesium Advisory Commitee

We publish below two letters concerning the Magnesium Advisory Committee whose formation was announced in our March issue. The first, from Mr. R. J. Cross, Managing Director, is a statement of the position of Essex Aero, Ltd. in this matter, and the second, from Mr. E. Player, Chairman of the Magnesium Advisory Committee, refers to a similar statement made by Rooster Publicity, Ltd., on behalf of Essex Aero, Ltd.

The Editor, METALLURGIA.
Dear Sir,

Essex Aero, Ltd. wish to make it quite clear that they were not in any way concerned in the recent formation of a Magnesium Advisory Committee said to have been set up by the principal companies of the magnesium industry.

As Ministry of Supply returns show, this Company was responsible during the period January 1st, 1950, to December 31st, 1951, for an output of 1,439 tons of rolled sheet and strip magnesium (some of which has been exported to the U.S.A.) of the total overall U.K. output of 1,487 tons, added to which there is a large annual output of cast products from the Company's foundry. The Company, therefore, considers itself to be a major producer.

The Company was asked to participate in this enterprise but felt bound in the interests of the industry as a whole to preserve its complete independence.

In the use of the words "The principal companies in the U.K. magnesium industry have formed a consultative and advisory body to be known as the Magnesium Advisory Committee," the statement is not strictly accurate, with similar remarks applying to "and to serve as the official liaison body for negotiations with the Ministry of Supply, Ministry of Materials and other Government Departments on all related subjects," and as producers of approximately 97% of the total output of rolled and strip magnesium in the United Kingdom, we are bound to point this out.

Added to which, the last paragraph of the announcement would appear to imply that the virgin magnesium supply to this country is limited to that "which is extracted in quantity from entirely domestic materials" (to quote), which, to our way of thinking, should read "can be extracted," since the major supply of virgin magnesium at the moment is, as with aluminium, of Canadian origin.

Yours faithfully,
For and on behalf of Essex Aero, Ltd.,
The Airport, R. J. CROSS, Managing Director.
Gravesend, Kent. April 1st, 1952.

The Editor, METALLURGIA.
Dear Sir,

My attention has been drawn to a statement concerning the Magnesium Advisory Committee, made by Rooster Publicity, Ltd. on behalf of Essex Aero, Ltd.

The formation of this representative Committee has been welcomed by the Ministry of Supply as affording a useful means of consultation between the industry and the Ministry on matters of mutual interest in the magnesium field. It is not concerned with sale prices and in no sense affects the independence of individual members.

Essex Aero, Ltd. refused an invitation to co-operate, as they were fully entitled so to do. Their abstention is regretted and the invitation to join the new Committee remains open to them at any time they care to accept it.

Yours faithfully,
E. PLAYER, Chairman,
Magnesium Advisory Committee.
Smethick, Birmingham, 40. March 28th, 1952.

Tool Steel Agency Change

WE are advised by Richd. W. Carr & Co., Ltd., of Sheffield, that they have now terminated their agency agreement with Messrs. Brooks & Walker, Ltd., of 41, Dockhead, London, S.E.1., for the sale of "Motor" Brand Fine Tool Steels and Engineers Tools in the London and Home Counties area. This area is now being worked from the Company's branch office at 38, Coram St., London, W.C.1. (Telephone: Terminus 8410; telegram: Carrlond, Holb. London, and is under the supervision of Mr. J. Leavesley Buxton, Sales Director. He is being assisted in the working of the area by Mr. E. F. Wren and Mr. G. W. Hobbs, both of whom have had long experience of selling tool steels. The aim is to give prompt and efficient service from the London Branch, backed up by deliveries from the Works in Sheffield and from the Warehouse and Heat-Treatment Department in Birmingham.

Stress-Strain Relationship of a High-Tensile Weldable Structural Steel

By D. W. Smith,* M.B.E., A.I.M., and J. G. Whitman,†M.Eng., Ph.D., A.M.I.C.E.
in collaboration with C. L. M. Cottrell,‡ M.Sc.

In order to save weight in the construction of a prefabricated transportable bridge, a straight carbon manganese steel was replaced by a low-carbon manganese molybdenum steel, but the expected advantages of using such a steel were not realised due to the low limit of proportionality exhibited. Considerable improvement could be effected by tempering at 600°.

THIS paper describes an investigation into the relationship between stress and strain, up to the 0·3% proof stress, of a high-tensile weldable structural steel used in the construction of a prefabricated transportable bridge. The steel under consideration is a low-carbon, manganese-molybdenum steel which gave a minimum 0·3% proof stress of 28 tons/sq. in. for thicknesses of less than half an inch in the as-rolled condition.

Previously, a straight carbon-manganese steel had been used for this type of work with a 0·3% proof stress of 23 tons/sq. in. so that, at first sight, the new steel promised a weight saving of approximately 20%. Such a saving would be invaluable in this type of structure where the economies of transport and erection are so dependent on the weight of the individual units.

It soon became apparent, however, that in the as-rolled condition there was a marked difference in the stress-strain curves of these two steels for values up to the proof stress. Whereas the carbon-manganese steel fulfilled the normal design assumption of a limit of proportionality reasonably close to the yield point, with very little difference between the 0·1 and 0·5% proof stresses, this new steel was found to have a comparatively low limit of proportionality, approximately 12 tons/sq. in.: in addition, there was a difference of more than 2 tons/sq. in. between the 0·1, 0·2 and 0·3% proof stresses.

Such a characteristic would probably be considered a disadvantage in most structures because, if working stresses were based on the proof stress, there would be a possibility of reduced crippling stress for compression members and, also, of increased deflections. For this particular application, however, a low limit of proportionality was prohibitive because the individual components might distort sufficiently to endanger the interchangeability of parts and, therefore, the whole purpose of the prefabrication.

TABLE I.—COMPOSITION OF STEELS

Steel No.	1	2	3	4
Mark	K.1834	N.2310	Original K	L.6464
	%	%	%	%
Carbon	0·17	0·17	0·18	0·18
Silicon	0·06	0·16	0·22	0·17
Manganese	1·27	1·39	1·26	1·48
Sulphur	0·027	0·033	0·010	0·017
Phosphorus	0·020	0·020	0·028	0·020
Nickel	0·43	0·41	0·39	0·33
Chromium	0·07	0·06	0·14	0·04
Molybdenum	0·25	0·31	0·23	0·23
Copper	0·29	0·35	0·12	0·24
Vanadium	—	0·04	0·05	—

Even under working loads, the permanent set given to members was of the same order as the manufacturer's tolerances on ruling dimensions, while a proving load, which is applied as an over-load to each part in the course of manufacture, would cause distortions sufficient to prevent assembly taking place.

Tests confirmed that the non-elastic behaviour of this steel was characteristic of complete structural members, as well as of tensile test pieces and, in order to make full use of the proof stress available, it was decided to carry out an investigation with the object of providing a commercially practicable means of extending the linear part of the stress-strain curve as near as possible to this value.

The investigation was carried out by the Inspectorate of Electrical and Mechanical Equipment in collaboration with the Military Engineering Experimental Establishment, the British Welding Research Association and Messrs. Colvilles, Ltd., manufacturers of the steel.

It was obviously not practicable to specify a minimum limit of proportionality in a commercial tensile test, particularly as this stress depends to some extent on the

* Inspectorate of Electrical and Mechanical Equipment, Ministry of Supply.
† Military Engineering Experimental Establishment, Ministry of Supply.
‡ British Welding Research Association.

TABLE II.—TENSILE TESTS ON HOT ROLLED MANGANESE-MOLYBDENUM STEELS.

Cast No.	Molybdenum %		Limit of Proportionality Tons/sq.in.	Proof Stress Tons/sq. in.				Ultimate Tensile Stress Tons/sq.in.	Elongation % on 2 in.
	Cast Analysis	Specimen		0·02%	0·1%	0·2%	0·3%		
Test Piece:									
Original K.	0·23	0·23	20·0	24·0	28·1	30·8	32·0	43·7	23
K.1834	0·25	0·25	19·0	21·8	26·5	29·3	30·9	43·0	20
N.2310	0·32	0·31	14·6	19·7	27·1	29·6	31·4	42·6	22
Web joist:									
L.6464	0·27	0·23	22·2	25·2	30·1	32·5	33·5	—	—
	0·27	0·23	29·4	31·2	33·3	34·3	34·6	—	—

Test Pieces: Diameter 0·4 in. Area 0·125 sq. in. Gauge Length 2 in., taken from root of 6 × 3 in. channel. L.6464 tested as 3 × 1½ in. R.S.J. Area 1·177 sq. in. Gauge Length 8 in. *Extensometer:* Clock type.

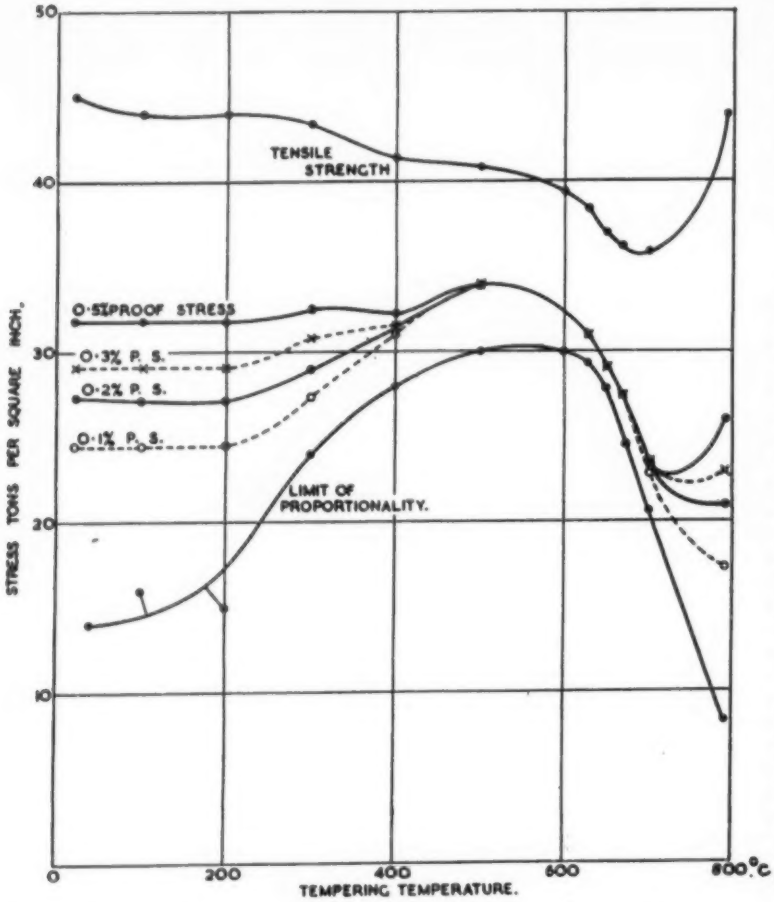

Fig. 1.—Effect of tempering temperature on $\frac{1}{2}$ in. manganese-molybdenum steel plate.

accuracy of the extensometer used and it was, therefore, decided to introduce a new proof stress for 0·02% permanent extension. This would represent the limit of distortion allowable for the structure and would also serve as a practical equivalent of limit of proportionality.

Mechanical Testing and Metallurgical Examination of Steels

Tensile tests were carried out on the manganese-molybdenum steels listed in Table I, in the hot-rolled condition and after heat-treatment. The results of tensile tests carried out by the Military Engineering Experimental Establishment are given in Table II. Most of the heat-treatment tests (made by the Inspectorate of Electrical and Mechanical Equipment) were carried out on steels 1 and 2, but the character of the original stress-strain curves and the results of heat-treatment were similar for all the steels and are summarised in Table III. Measurements of strain were made with a sensitive mirror extensometer.

The most noticeable feature of the tests in both the hot-rolled and the normalised conditions was the very low limit of proportionality, a characteristic which was eliminated by tempering at a sufficiently high temperature but which reappeared, accompanied by a distinct hardening effect and a pronounced fall in notched-bar impact value, when the tempering temperature approached the critical range. This behaviour

TABLE III.—TENSILE TESTS ON MANGANESE-MOLYBDENUM STEELS AS ROLLED AND AFTER HEAT TREATMENT

Cast No. and Condition	Limit of Proportionality Tons/sq. in.	Proof Stress Tons/sq. in.				Ultimate Stress Tons/sq. in.	Elongation % on 8 in.	Izod Impact Value Ft. lb.	Remarks: Microstructure
		0·02%	0·1%	0·2%	0·3%				
K.1834									
As rolled	11	19·4	24·5	25·8	26·7	37·8	18	—	Low L. of P. Martensite present in small particles.
N.2310									
As rolled	11	21·7	27·8	30·2	31·2	41·7	14	40–73	Low L. of P. Martensite present in small particles.
As rolled, tempered 500° C.	16	25·0	30·4	32·2	—	40·6	16	72–76	Traces only of martensite left.
As rolled, tempered 700° C.	9	16·0	23·0	26·8	29·2	58·4	7	6–7	Hardened (Ac_1 700° C.). Structure ferrite and martensite.
Normalised 860° C.	11	18·7	25·4	28·1	—	41·2	14	44–98	Low L. of P. Martensite present in small particles.
Normalised, tempered 500° C.	16	26·2	30·0	30·7	31·5	39·5	12	67–86	Traces only of martensite left.
Normalised, tempered 700° C. then 550° C. (2 hrs.)	18	25·9	31·6	—	—	44·0	13	74–78	Martensite (formed by cooling from 700° C.) tempered, giving coarse sorbitic coalesced carbide.
Cooled in air from 860° C. to 500° C.; held at 500° C. (1 hr.) and cooled in air	9	16·1	23·4	26·6	28·3	45·3	16	10–22	Martensite present. The austenite to martensite transformation mainly occurs below 500° C.
"Original K"									
As rolled	15	25·8	29·6	—	—	43·9	14	23–43	Martensite present.
As rolled, tempered 600° C.	25	33·6	—	—	35·4	42·0	15	83–103	No martensite.
Normalised 860° C.	7	14·1	27·1	—	—	41·9	16	39–47	Martensite present.
Normalised, tempered 600° C.	16	24·0	27·8	28·8	—	39·6	18	98–106	Traces only of martensite left.

Tensile Specimens: 1½-in. wide from web. *Extensometer:* Lamb's 8-in. mirror type. *Izod Specimens:* From root corner. *Normalising Time:* 15 minutes. *Tempering Time:* 1 hr. unless otherwise stated: cooled in air.

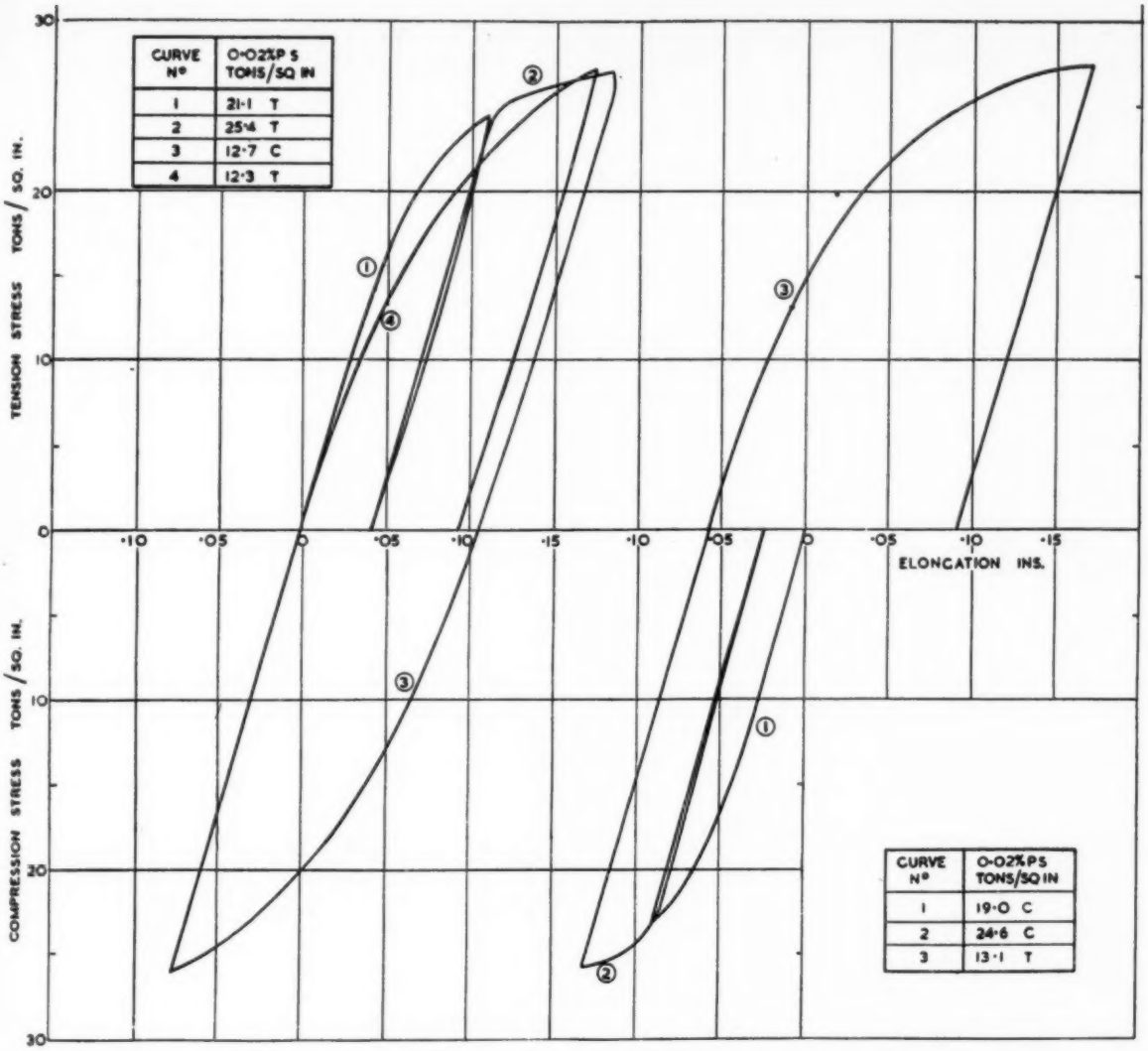

Fig. 2.—Behaviour of typical structural members under alternate tension and compression loading. (6 × 3 in. channels, K.1834, gauge length 36 in.)

is illustrated in Fig. 1, which represents the results of tests carried out by the British Welding Research Association on normalised ½-in. plate of a similar manganese-molybdenum steel. It is common to high-tensile steels of different compositions but similar properties and was, for example, shown by normalised ½-in. plate containing carbon 0·16, manganese 1·15, nickel 1·0, chromium 0·25 and molybdenum 0·22%. It was not observed in low-carbon manganese-molybdenum 1-in. plate containing only 0·13% molybdenum; this steel showed good proportionality of stress to strain, a clearly defined yield point and uniformly high Izod values both in the hot-rolled and normalised conditions and after tempering at temperatures up to 700° C.

Microscopical examination at high magnification of the steels with low limits of proportionality revealed, usually in the pearlitic regions, very small dispersed particles of an austenite decomposition product, probably an irresolvable martensite.

The particles of the austenite decomposition product have frequently been observed in steels cooled at rates bordering on the critical cooling velocity, or cooled rapidly after being heated up to the lower limit of the critical range.* Thus in steel N.2310 the critical range on heating was found by dilatometer to extend from 700°–820° C. On reaching 700° C. (Ac_1), the ferrite and carbide of the pearlite go into solid solution forming isolated patches of austenite, which would absorb more ferrite if the temperature were raised, finally becoming wholly austenitic above Ac_3 (820° C. for this steel). Thus, at 700° C. the steel consists of austenite (relatively rich in carbon, manganese and molybdenum) in a groundmass of ferrite, and on fairly rapid air-cooling the ferrite remains unchanged while the austenite is

* See, for example, L. Aitchison, *Carnegie Scholarship Memoirs, Iron and Steel Institute*, 1923, page 143 (Fig. 12) for low elastic limit of air-hardening steels; J. A. Jones, *Journal, Iron and Steel Institute*, 1925 (1), page 377 (Fig. A) for effect of cooling from Ac_1; B. Jones and N. Gray, *J.I.S.I.*, 1938 (1), pages 327–348, for martensitic grains in rapidly cooled mild steel; and J. A. Jones, *idem*, page 355 (Figs. A–D) for the same in 1·6% Mn steel.

transformed to martensite, the steel as a whole showing appreciable hardening and a low limit of proportionality (Table III). Under the conditions of cooling involved, the familiar acicular structure of "quenched" martensite is not developed. On tempering the steel at 550° C. the martensite forms a sorbitic structure of coalesced carbide, the steel is again softened and the elastic properties are restored (Table III). On heating to 800 and 900° C. martensite particles reappear but are again broken down on reheating. Even before it has a marked effect on the hardness, a structure containing martensite particles is associated with a lowering of the limit of proportionality and of the notched-bar impact value.

The X-ray diffraction patterns showed features in good correlation with the microstructure. The presence of martensite interfered with the resolution of the Kα doublet giving a diffuse appearance resembling that given by internal strain, while full resolution of the doublet was obtained in the material tempered at 600° C. in which neither martensite nor internal strain was present.

Influence of Composition

The peculiarities of the stress-strain curve and the formation of martensite appear to be closely related to the molybdenum content of the steel. As already mentioned, manganese-molybdenum steel with 0·13% molybdenum does not show these characteristics, but its yield strength is inadequate. With increase in the amount of molybdenum present, delay in the austenite—pearlite transformation causes the retention of a certain amount of austenite which transforms at a lower temperature. There is a considerable increase in this "air-hardening" effect when the molybdenum is raised from 0·2–0·3%. Tests on steel containing over 0·2% molybdenum, in the hot-rolled condition, did not consistently give a low limit of proportionality. One steel (L.6464, described as "grain controlled") gave the usual departure from proportionality in most joists tested, but occasionally gave tests showing a high limit of proportionality (Table II). Examination of specimens giving each type of curve showed identical analysis in both cases (carbon 0·18, manganese 1·48, molybdenum 0·23%) differing slightly from the cast analysis (carbon 0·18, manganese 1·38, molybdenum 0·27%). Martensite particles were present in the specimens giving a low limit of proportionality but not in those giving a high limit. It might appear that a slightly lower hardenability than usual made the steel extremely sensitive to the rate of air-cooling after rolling; but the makers state that Jominy tests on grain controlled casts and on casts made without the aluminium addition gave no evidence of any significant difference in hardenability, and it was considered that the certain avoidance of low limits of proportionality in hot-rolled steel of this molybdenum content could not be ensured by further control of manufacturing procedure.

Effect of Pre-stressing

As a single application of load up to a point on the non-linear part of the stress-strain curve produced a much more nearly linear relationship on subsequent loading, tests were made to see whether pre-stressing might not provide an easily applied, economical method of raising the limit of proportionality. Both tension and compression tests were necessary, as the bridge members are subject to compression and/or tension loads. The results showed that provided the load was re-applied in the same sense, an improvement was obtained in the 0·02% proof stress. If, however, the load was re-applied in the opposite sense, a slight drop was noticeable. As a final check, two specimens consisting of typical structural members were subjected to alternate tension and compression loading, as shown in Fig. 2. These results illustrate the stress-strain relationships with different combinations of tension and compression loading, and indicate that as the normal hysteresis loop is applicable to this early departure from proportionality, no overall advantage is to be gained by pre-stressing.

Conclusions

(1) The high-tensile manganese-molybdenum steel employed in bridge construction shows, in the hot-rolled or normalised condition, a low limit of proportionality which could adversely affect the strength of the bridges and the interchangeability of parts.

(2) It is not possible to raise the limit of proportionality for both tension and compression loading by pre-stressing in either sense.

(3) Greatly improved limit of proportionality and notched-bar impact figures are obtained by tempering at 600° C.

(4) The low limit of proportionality in relation to yield stress is avoided if carbon and molybdenum content are reduced, but the strength of the steel is then inadequate.

(5) A 0·02% proof stress of 20·5 tons/sq. in. is generally (but not with complete certainty) obtainable in the hot-rolled condition in steel containing carbon 0·18, manganese 1·35 and molybdenum 0·25%; but a higher value cannot consistently be obtained without tempering.

Acknowledgments

It is desired to acknowledge the valuable assistance given by Dr. R. H. Greaves in the preparation of this report.

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Statistical Summary of the Mineral Industry

H.M. Stationery Office: Price 25s.

THE present edition of the Statistical Summary of the Mineral Industry, formerly published for the Imperial Institute, covers the seven-year period from 1944 to 1950. The statistics cover the production, imports and exports of more than 50 minerals and metals which are arranged in alphabetical order from Asbestos to Zirconium. In the case of copper, lead, tin and zinc, tables are included showing the production of ore in terms of metal, in addition to smelter production. The section on coal deals also with coke, briquettes and the chief coal by-products, while that on petroleum is concerned with crude petroleum, natural gasoline, natural gas, asphalt, oil-shale and the chief refinery products. The iron and steel section gives information on iron-ore, pig-iron, including ferro-alloys, and steel. The import and export tables refer not only to the crude minerals and metals but also to the chief semi-manufactures and in some cases to the principal chemicals and their derivatives.

By the Mineral Resources Division of Colonial Geological Surveys.

Modern Extrusion Plant

Aston Chain and Hook Company Development

General view of the plant showing the press and its control panel on the right, the air-hydraulic accumulator in the centre, and the pumping equipment on the left, with the coiler in the left foreground.

THE Aston Chain and Hook Co., Ltd., of Erdington, Birmingham, have recently put into commission a new extrusion plant which possesses a number of interesting features. This installation includes a 2,000/200 ton Fielding horizontal extrusion press together with the necessary billet handling and heating equipment. Of the three-column type, the press has two columns at the top and one below, instead of the more usual single top column. The two-top-columns arrangement has the distinct advantage of facilitating container changing, although it necessitates an inclined billet loader. A special feature of the press is the provision of automatic control of the speed of extrusion which can be pre-set by the operator. The billet handling equipment is also worthy of note and the labour force required for the operation of the plant is reduced by having all operations—from billet loading (into the furnace) to extrusion—controlled from the main control desk; a subsidiary desk houses the controls concerned with post-extrusion operations.

Loading the Billet Heating Furnace

For both charging and discharging the billet heating furnace there is a conveyor installation made by The British Wedge Wire Co., Ltd. Designed to handle billets ranging in size from 6 in. diameter × 10 in. long (90 lb.) to 10 in. diameter × 30 in. long (7 cwt.), the feed conveyor is situated close to the billet cut-off machines and is fed from them by means of an overhead runway operated by the cut-off machine operator.

The conveyor consists of three parallel lines of vee roller tracks. The rollers in the first sections of each line are static, the following sections slow power driven, and the final sections feeding the lifting sections fast power driven. The fast final section carries the leading billet forward away from the line of billets, and immediately this leading billet arrives in position on the lifting section, it operates a cut-out trip switch, thereby causing the feed line to become dead. The fast roller sections, the lifting sections and the automatic trips are adjustable to suit the varying lengths of billets. Only one length of billet is used on any one line at one time.

The Heating Furnace

The oil-fired billet heating furnace, designed and built by Fuel Furnaces, Ltd., has a hearth which is 27 ft. long (based on twelve 2 ft. 3 in. billets) and 3 ft. 6 in. wide. Three parallel vee grooves lined with nickel-chromium run the length of the furnace, in line with the three conveyor roller tracks, and it is along these that the billets are pushed by the loading rams, which are synchronised and controlled by the billet handling gear.

The discharge end of the furnace is built in the form of an additional chamber, adding 3 ft. 3 in. to the length of the hearth, and having a width of 5 ft. 3 in. The floor of this chamber is formed by a heavy cast plate, having vee-shaped impressions in line with those in the furnace hearth. The plate is mounted upon machined nickel-chromium rollers carried in cast nickel-chromium channels and is connected by push-rods to two horizontal

Billets being loaded on to the conveyor feeding the furnace charging mechanism.

air cylinders, by means of which it may either be held firmly against the front edge of the hearth whilst a billet is pushed on to it, or be withdrawn 6 in. clear from the front edge of the hearth to separate the billet from those in the furnace, so that it can be rolled out sideways through the discharging door. These 6 in. stroke cylinders are also synchronised and controlled by the billet handling gear.

The furnace is fired by twelve small low-pressure oil burners, six along each side, and the oil and air supplies are so arranged that the flow of oil is proportional to that of the air. This enables the temperature to be controlled by the manipulation of the air valves only, and also provides the safeguard that should the air blowing fan stop for any reason, the flow of oil ceases also. The air for combustion is heated in waste gas recuperators and the oil is thermostatically controlled at 150°–170° F. in small tanks equipped with immersion heaters and situated close to the burners. The hot waste gases are also used to preheat the cold billets on their way to the heating zones of the furnace.

In order to achieve satisfactory automatic control of temperature without loss of output the furnace is divided into two zones each governed by a large-scale potentiometric controlling recorder. A third recorder, of the high speed type, is coupled to a special temperature measuring device at the point where the hot billet enters the press. In this way, the temperature of each billet is recorded separately and the number passed through may be counted from the same chart. An extension from this instrument energises an indicator on the desk from which the plant as a whole is controlled, so that the operator may check the temperature of each billet before passing it into the press.

The furnace is rated to heat to 850° C. 5,400 lb./hr. of copper billets for the expenditure of 11½ gallons of fuel oil per hour. This is a safe estimate representing a thermal efficiency of approximately 42%.

The Discharge Conveyor

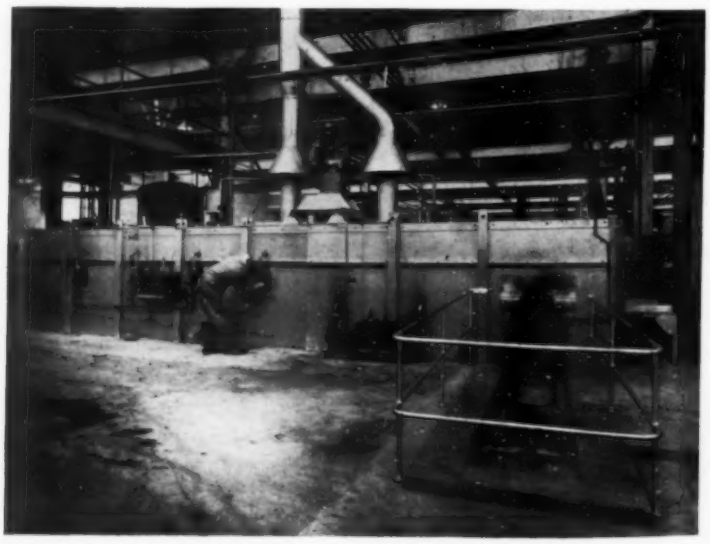
The discharge conveyor is situated at right angles to the furnace and carries the hot billets from the furnace to the horizontal extrusion press. It consists of a plate and roller track down which the billets roll. The rollers are at right angles to the billets. Above the track is arranged a twin chain conveyor with cross bars at intervals to control the billets, whilst set diagonally across the track is a spring-loaded gate, which automatically adjusts any length of billet to feed centrally to the lifting section of the press. The conveyor is set in motion and stopped automatically by a billet entering and leaving the conveyor feed and discharge sections.

The Pneumatic System

The application of pneumatic cylinders to the handling installation of this plant is an example well worthy of consideration. The opening and closing of doors on furnaces and the intermittent feeding of muffles are both old established practices in pneumatic installations, but never before has the whole circuit been operated from one central position. The valve gear for the pneumatic circuit was supplied by Benton and Stone, Ltd.

The operator decides, according to requirements, from which of the three lines a billet is to be selected. He then presses a lever, which operates the pneumatic system controlling the selected line. Immediately, the lifting section, which contains a billet, is raised to the level of the furnace hearth, an air valve is operated which in turn releases air pressure to the billet pusher cylinder. The billet is then thrust off the lifting platform and into the furnace, at the same time the billet required by the operator is thrust forward to the discharge platform, or sill plate, of the furnace, and the furnace door is raised. At the full extent of the thruster stroke a valve controlling the discharge platform mechanism is operated, causing the discharge platform, containing one billet, to move forward a few inches away from the dead line of billets. This allows free discharge of the billet. At the completion of this operation, the discharge thruster is set in motion and pushes the billet off the platform through the side door opening to the discharge conveyor. At the completion of the discharge thruster stroke, a release valve is operated which returns all thrusters, etc., to the neutral or start position.

Lift and pusher mechanism for charging the furnace.



Billet heating furnace with (right) push-off cylinder for automatic feeding of billets to press.

The billet has now left the furnace and rolled on to the conveyor platform. As it arrives in position, the billet, which is now hot, actuates a lever switch which sets the conveyor in motion. The billet is carried forward and deposited on to the billet loader of the extrusion press. The conveyor stops automatically on completing a half cycle.

We now revert to the pneumatic system which has returned all thrusters, etc., to the start position. As the billet lifting section returns to the feed start position, a contactor switch is tripped; this sets in motion the power roller feed line from which a billet has been selected and another billet is automatically delivered to the lifting section, ready for the operator as required. By this method, one billet is always in position on each lifting section.

The whole cycle is completed in 30 seconds, maximum.

At times it becomes necessary to change over the size of billets in use, and to facilitate this operation a by-pass valve is incorporated in the pneumatic system which cuts out all operation other than the feed conveyors' lifting section and furnace feed thrusters. By bringing this valve into operation, billets can be pushed straight through the furnace and discharged in a straight line through the furnace end door opening.

The Horizontal Extrusion Press

The "Fielding" 2,000/200 ton horizontal extrusion press, as already stated, is of the three column type with two top columns, and is equipped with independent piercing gear, hydraulically operated wedge lifting device, hydraulically operated vertical shear, hydraulic die-shifting arrangement, pre-filling equipment for the main and piercing cylinders, and saw for cutting off extruded sections of a complicated nature.

The columns are located in bosses integral with the main cylinder which is of cast steel and are retained by split type cast steel nuts provided with locking device. The main ram, which is machined to a high polish along its working length, is provided with an integral extension for piercer gear and is also fitted at its forward end with a crosshead which supports and guides the main ram. To this crosshead are fitted the thrust rod and main drawback rams. Glands of the outside packed type are fitted for ease of maintenance.

Loading of the billets into the press is effected by a special inclined hydraulic loader on which the heated billet is placed by the furnace discharge conveyor. This loader raises the billet to the centre line of the press, the operation being controlled by the press operator from the control desk.

The billet is first loaded into the container (which is maintained at a suitable temperature by gas heating) by the preliminary forward stroke of the thrust rod attached to the main ram, the ram then being withdrawn and the pressing pad brought into position by the loading gear. The main ram is again brought forward and the pressing pad is pushed into the container against the billet. The main ram then continues its full stroke, travel of the ram being terminated by a stop block on the face of the container, or by the action of the press operator.

The die which determines the particular shape or section of the metal to be extruded is accommodated in a die assembly carrier and this is retained in position in the die housing by a hydraulically operated wedge, thus sealing the die against the container mouth during extrusion. The wedge is raised on completion of extrusion

View showing automatic conveyor from furnace to press with billet in position for lifting.

to allow the die assembly carrier to be moved out from the die housing to the vertical hydraulic shear, or the saw, for removal of the discard, etc.

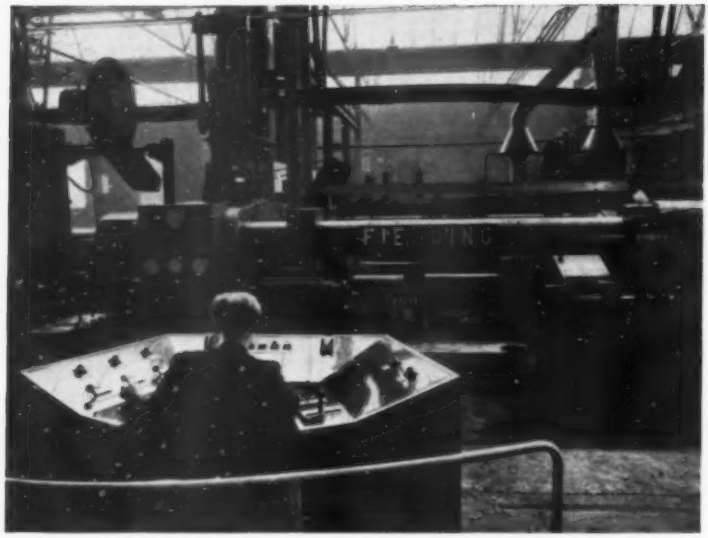
Movement of the die assembly carrier in or out of its sealed position in the die housing against the container housing to the run-out channel is effected by two opposed action horizontal cylinders and fixed rams mounted on a two-part bedplate secured to the main die housing. The stop block previously referred to, which terminates the travel of the ram, is of heavy steel plate located in vertical guides on the face of the container, and this block is raised vertically (in conjunction with the wedge) by wire ropes attached to the wedge operating ram crosshead, to allow the discard and thrust pad to be ejected from the container.

After the extrusion is completed, the die carrier is run-out to the shearing position, the discard and pressing pad adhering to the die face. A hydraulic support is operated to support the pressing pad so that the one movement of shear blade will shear the extrusion from discard and also separate the discard from the pressing pad. The discard will drop on to a chute arranged in the shear frame which delivers the discard into a bin situated in a pit near the shear. At the same time the pressing pad will automatically roll down an inclined guide on to a transfer channel which is so designed as to turn the pressing pad through 180°: this brings the correct face of the pressing pad into its true relative position for loading in the pad loader head.

A pendulum type saw suspended from a structurally supported shaft accommodated between the die housing and the vertical shear is fitted and may be used for cutting off discard of either solid or tubular extrusions.

Two lever type ejectors are arranged, one for ejecting the extrusion from the die and one for ejecting the die from the die holder. A quick release mechanism is fitted to the ejectors so that a minimum of time is lost when changing ejectors.

The various controls for the press movements such as main ram, billet and pad loader, wedge and die carrier run-out, are all so interlocked that, should the press operator make a mistake in the sequence of movement



View from rear of control desk shows billet raised on the billet loader ready for insertion into the liner.

View showing run-out channel and coiler.

for any of the above items, all movement would immediately stop and further relative movement of any component would be impossible until the mistake had been rectified and the particular item restored to its correct position. The mistake would be registered on the control panel by means of a red light showing opposite the name of the particular item causing the trouble. The safety of the press against damage is thus well ensured by these interlocking devices.

Power for the operation of the press is provided by a Fielding air-hydraulic accumulator system using lubricated water as the pressure medium at a maximum working pressure of 3,500 lb./sq. in. The accumulator comprises one pressure bottle and three air bottles interconnected by piping. The air bottles are charged with air at 3,500 lb./sq. in., but the water bottle is only partly filled with water, the working level being fixed by the capacity required. Air from the air bottles is let into the water bottle so that the water is under the same pressure as the air, and as water is withdrawn from the pressure bottle, the air expands slightly causing a slight drop in pressure, while at pre-determined levels water is automatically pumped back into the bottle from an outside elevated Horsley Piggott type supply tank by a Fielding Type H.8 hydraulic pump. Although no air is used from the air bottles, when the accumulaor has been in operation for some time a gradual fall in pressure may be observed; this is corrected by a Hamworthy compressor.

Control of the press is effected through mitre-seated balanced type valves which, with the exception of the pad loading cylinder, are servo operated. Movement of these valves is obtained by rocker shafts which are operated by means of servo cylinders controlled from small lever-operated piston valves at the control desk.

The servo system consists of Lockheed control valves remotely controlling the servo cylinders which are mounted on the valve stands. The Lockheed valves are housed or mounted in two control desks. The larger or main control desk houses the Lockheed controls for the main cylinder, speed control, piercing cylinder, billet loading cylinder, pad loading cylinder and wedge operating cylinder, and the smaller desk for the shear operating cylinder, die carrier run-out gear, pad supporting cylinder. Arrangements are made for individual and combined control of the main and piercer control valve levers, enabling the piercer power to be used to augment the main ram power, if required for solid extrusions.

The speed control valve which is directly controlled by a double acting balanced piston determines the main ram pressing speed. The piston, in turn, is controlled by the Lockheed metering valve mounted in the main control desk. Manipulation of the lever of this valve supplies oil at 400 lb./sq. in. from an accumulator (also housed in the main control desk) to either side of the piston controlling the speed control valve. When the lever is in the neutral position, the circuit is closed and the piston locked in the desired position. The piston and hence the speed control valve spindle can be held positively in any pre-determined position. In this way the speed of the main ram of the press can be set at a pre-determined maximum. An indicator is mechanically connected to the speed control valve piston to indicate its position in the cylinder. It is possible, therefore, to pre-set the speed control valve to give any required pressing speed. The pressing speed is automatically indicated on a Cambridge instrument, and any fluctuation can be readily adjusted by manipulation of the metering valve lever on the main control desk.

In order to provide fast approach of the main and piercing rams before the main high pressure is required to complete the extrusion, a pre-filling tank system is employed. Low pressure water at approximately 100 lb./sq. in. from the pre-filling tank is supplied to the main and piercing cylinders of the press via filling valves to effect the preliminary working stroke of these rams until the resistance of the billet is encountered, when high pressure water is used for the main pressing stroke until the extrusion is completed.

Coiling Machines

In addition to the main plant, coiling machines for dealing with the hot extruded rods and sections have

been built to Aston Chain and Hook design and specification.

The vertical coiler, designed to deal with round rods up to $\frac{3}{4}$ in. diameter, is situated at the rear of the press and adjacent to the runout channel. Hot rods are fed into the coiler pan through a rectangular steel tube which is hinged and quickly swung clear of the dieholder when the discard is sheared off.

The coiling machine itself consists of a Kopp 5 h.p. 400/440 volts Variator motor, coupled by a flexible coupling to a worm reduction unit, driving a dished coiling pan. In the base is fitted a quadrant, which rotates with the pan. When the extrusion is completed, the quadrant is pushed clear of the pan by an air cylinder, and the coiled rod is pulled on to a gravity conveyor to be stacked on stillages for transfer in readiness for the next process. The speed of coiling ranges from 100–950 ft./min.

The horizontal coilers for coiling rectangular and complex sections are hand fed from the runout channel of the press, and situated at the extreme end of the channel. To obtain simple yet efficient coiling speeds, air operated engines are used. These have been specially made by Messrs. Austin Hopkinson, and have a working pressure of 80 lb./sq. in.

The coiling pegs are fitted to a plate that is integral with the motor. The motor is located on four round rod slides, which form part of the machine frame. A 4 in. bore air cylinder is connected to the motor, which retracts the coiling pegs into the machine, and the extruded section is forced off the coiling pegs and slides to the floor for stacking or transporting to its next process.

Compressed air (100 lb./sq. in.) for the coiling machines and cylinders on the furnace manipulating plant is supplied from a Broom and Wade D.24 twin cylinder single-stage compressor, driven by a 35 h.p. S.C. motor. A 100/80 lb./sq. in. reducing valve is fitted in the main airline to the two horizontal coiling machines.

Dust in Steel Foundries

THE Second Report of a Committee appointed to consider methods of preventing the production or the inhalation of dust and the possibility of reducing the use of materials containing free silica in steel foundries has recently been published by the Factory Department of the Ministry of Labour and National Service.*

In 1944 the Committee, which is representative of the employers, trades unions and the Factory Department, published the First Report on Dust in Steel Foundries. At that time the Members had completed a general review of the various dusty processes in steel foundries, and had agreed on recommendations in relation to a number of them. It had, however, become evident to the Committee that some of the questions discussed raised involved technical and scientific issues and that further and, perhaps, prolonged enquiry and research work would be necessary. Since the publication of the First Report the Committee has held sixteen meetings and has also sponsored both research work and field investigations in an effort to assist the industry in the control of dust. This Second Report has now been published because, although there are still many problems awaiting a solution, the Committee consider that the time is opportune for its publication in order to inform the steel founding industry of the progress that has been made and the general lines of approach that are being pursued by the Committee.

Medical Aspect

Since the publication of the First Report, a member of the Committee (Dr. A. I. G. McLaughlin) has, with others, conducted a wide medical survey of the incidence of pulmonary dust diseases in foundry workers. The survey which was published as a Report in 1950, included a field investigation in 19 foundries, including iron and steel foundries, three of which were mixed iron and steel foundries; an analysis of the records of pulmonary disease in foundry workers contained in the files of the Factory Department and the Silicosis Medical Board, and a study of the pathology of 64 deceased foundry workers.

In the field investigation over 3,000 people were examined clinically and by X-ray in 19 foundries, of which four were steel foundries and three were mixed iron and steel foundries. It might be thought that seven steel foundries do not constitute an adequate sample of steel foundry workers, but in addition to the cases examined and analysed statistically in the field investigation, information about the occurrence of silicosis and other forms of pneumoconiosis was drawn from more than sixty steel foundries (in addition to iron foundries) in different parts of the country. When it is realised that there are, in Great Britain, only 70 steel foundries (excluding those producing less than 50 tons per annum), it will be seen that a wide field has been covered.

It is indicated that there is a greater risk of the development of silicosis and accompanying X-ray abnormalities in steel foundry workers, with the exception of labourers, than in workers in iron, or mixed iron and steel foundry workers. Statistically, it is shown that workers in steel fettling shops are liable to develop more severe X-ray abnormalities than workers in any other foundry occupation. In particular, the fettlers of steel castings are exposed to a serious risk of silicosis often accompanied by tuberculosis. As was shown in the First Report, the numbers of steel fettlers certified by the Silicosis Medical Board as having silicosis have increased yearly since 1931, and the increase is still continuing. Probable reasons for the increase are given: (i) That the dust from the process is still not controlled; (ii) that many more fettlers are using pneumatic tools; and (iii) that the output of steel castings has doubled. By contrast, it states, the numbers of cases of silicosis among sand and shot blasters have not shown a comparable yearly increase, probably because the process of blasting is under regulations which prescribe dust control and protection of the workers.

It is pointed out that steel moulders and coremakers, provided that they are not exposed to the inhalation of dust from other foundry processes, have a lower incidence of X-ray abnormalities and silicosis than do the steel fettlers. They are exposed to a greater risk of silicosis if silica flour is used in the moulding mixtures without adequate dust control measures.

* On sale at Her Majesty's Stationery Office, price 3s. 6d. net.

Welders and oxy-acetylene cutters develop siderosis as the result of the inhalation of iron oxide fume; but when welding, oxy-acetylene flame cutting or burning are carried on in a steel fettling shop the welders and cutters are exposed to the risk of silicosis and mixed dust pneumoconiosis. Pure siderosis is not a disabling condition. In common with most other workers in steel foundries, knockout men, sand mixers and crane drivers show a higher incidence of X-ray abnormalities than the comparable group in iron or mixed iron and steel foundries. Men exposed to the inhalation of dust from the knockout are liable to contract silicosis but not to the same extent or as rapidly as blaster or fettlers. The risk to crane drivers is apparently greater in the fettling shop than it is in the moulding shop. Furnace workers, including casters, ladlemen, pourers and annealers, develop abnormal X-ray appearances after some years' exposure to the dust and fume arising from their jobs. The abnormal changes are more pronounced in steel foundry workers than they are in iron or mixed iron and steel foundries. The incidence of active tuberculosis among foundry workers is much the same as that found in the general population (3·6 cases per 1,000), though it is recognised that workers already suffering from silicosis are peculiarly liable to contract tuberculosis as well.

It is suggested that steel foundrymen should undergo pre-employment and periodical clinical and X-ray examinations. These have been in force for some years in Scandinavian countries such as Sweden and Denmark, and also in some parts of the United States. The Committee spent some time in trying to set up with the British Steel Founders' Association and the British Red Cross Society a comprehensive and practical scheme of periodical medical examinations which would assist further research and could be carried out at the same time as environmental studies. Although it was not possible to set up the scheme, the British Steel Founders' Association have proceeded with a scheme of their own, and a portable X-ray unit is, at present, touring the country so that member firms of the Association may arrange for X-ray photographs on behalf of their employees.

Remedial Measures

Apart from the Medical Section, the Second Report contains much valuable information on a number of subjects which have a bearing on the main issue, that of tackling the problem at its source. These include: *Legislation*; *Estimation of the Value of Remedial Measures* (General; Medical Examinations; Dust Examinations—General—Rapid Dust Estimations—Empirical Standards of Dust Control—Estimation of the Efficiency of Dust Suppression Devices—The Absolute Standard—The Observation of Dust Clouds); *Dust Suppression* (General; The Elimination of Dust; The Elimination of the Dangerous Fraction of the Dust—The Use of Silica Flour—the Flux Injected Burner; Dust Control—General; Dust Control by Wet Methods; Dust Control by Local Exhaust Ventilation—General—An Exhausted Fettling Bench—Swing Frame Grinder; Dust Control by Respirators); *Pathological and Biochemical Research*. The Report concludes with *Acknowledgments* to the many private steel founders, individuals and Associations who co-operated during the experiments.

"Kodak" Data Book

New Edition Published

The "Kodak" Data Book of Applied Photography was first published at Government request during the war when photography was brought into use in many new ways to aid war-time industry and training. As new techniques were developed, new materials and equipment made available, the "Kodak" Data Book expanded rapidly from one volume to three; new Data Sheets, many of them books in themselves, were added.

The low initial price at which the book was offered as a service to industry and science made it necessary to limit distribution to those directly concerned with the applications of photography in these fields, although many professional and serious amateur photographers were anxious to acquire it as a book of reference.

In view of the ever-increasing use of photography and the new and valuable information which is constantly being made available by them, Kodak Limited is now publishing a new edition of the "Kodak" Data Book. This comprehensive collection is now available to photographers generally. It costs 2½ guineas, and this price includes the 4-volume Data Book current at the time of despatch, and a year's supply of new Data Sheets, issued each March and September; annual subscription thereafter is 10s. 6d.

In the new edition all component Data Sheets have been revised, out-of-date sheets withdrawn, and new subjects added. The 800 pages of current information have been regrouped and classified under 20 sections, indicated by thumb-tabbed cards for quick reference. The war-time binders are superseded by attractively designed, loose-leaf binders, sturdily made to stand up to the constant handling to which these invaluable books are subjected.

The American Library's New Industries Section

The American Library, at 41, Grosvenor Square, W.1. has recently opened an industrial section, which includes American books, periodicals, government documents and other literature in the fields of technology, engineering, management, trade and agriculture.

Books and other material can be borrowed by anyone in Great Britain and, where necessary, will be sent by post. In cases where a book or periodical is not available for loan, photostatic copies of special articles will be provided free of charge. The Library also answers requests for information received by telephone or letter.

The Library works in close co-operation with British technical libraries and specialised research agencies, and acts as liaison with appropriate agencies in the United States where information in its own collection is not sufficient. It has full access to existing special American indexes which give complete reference by subject of all articles or books published throughout the English speaking world.

The Library is open to the public, Monday to Friday, from 9 a.m. to 6 p.m. All service is free and enquiries are welcomed. Communications should be addressed to: Industry Section, American Library, 41, Grosvenor Square, London, W.1. Enquiries will be answered by calling GROsvenor 9000, Extension 447 or 748.

THE BRITISH INDUSTRIES FAIR

Engineering Exhibits at Castle Bromwich

The financial problems facing this country at the present time serve to emphasize the fact that, in spite of the need for rearmament, with its demands on man-power and production machinery, Britain cannot afford to relax her efforts to increase exports to the markets of the world. With the decline of the seller's market, the displays of British products at Castle Bromwich, Birmingham, and at Olympia and Earls Court, London, assume a new and increasing importance. Apart from acting as a national shop window, the British Industries Fair provides opportunities for personal contacts to be established with home and overseas buyers. In this survey of exhibits, attention is mainly directed to metallurgical aspects of the Engineering Section at Castle Bromwich.

THE story of the British Industries Fair goes back almost thirty-eight years to the autumn of 1914. War had then engulfed most of Europe. Britain, long dependent on Germany and Austria for certain classes of manufacture, found herself cut off from her traditional sources of supply. To encourage British manufacturers to supply the missing goods themselves, the Board of Trade held a series of small exhibitions up and down the country so that manufacturers could view the types of foreign articles needed. Firms went to work in the winter, and the Board of Trade, struck by the quality of the new production, planned a national fair for early 1915.

The first British Industries Fair opened when Britain's energies were absorbed by war. Nevertheless, the response of British manufacturers was remarkable; 591 manufacturers took space covering nearly 90,000 sq. ft., and the emphasis on new inventions and developments, so evident in recent British Industries Fairs, was already apparent. Much interest was shown by the visiting merchants in new products, or products made for the first time in Britain. Glass, for example, and more especially commercial glass, was presented for the first time as a British product.

Throughout most of its history, space has been the limiting factor; the Fair has moved from building to building in the search for more extensive accommodation. Its first homes were the Royal Agricultural Hall, and, in the next year, the Victoria and Albert Museum, followed by buildings at the London Docks, and then the Crystal Palace.

In 1920, when the London section of the B.I.F. was staged at the Crystal Palace, the Birmingham section began; the heavy industries and hardware were housed at Castle Bromwich, in a World War I aeroplane hangar purchased by the Birmingham Chamber of Commerce. Then, in 1921, a section of the Fair was established in the Kelvin Hall, Glasgow, but the spread over three cities with 400 miles between them proved too big a transport problem for buyers, and the Glasgow section was discontinued, but Castle Bromwich still houses the heavy industries and hardware section.

In 1925, at the time of the Great Empire Exhibition at Wembley, the Fair was not held, and a further seven-year lapse was enforced during World War II. The Fair re-opened in 1947 on a scale larger than ever, and the struggle for space is to-day again a problem. Some idea of the progress the Fair has made can be obtained from the figures for overseas buyers attending. In the 1930's the average was 5,000, whilst the average for 1947–1949 was 16,000 and for 1950–1951, 19,000.

At Castle Bromwich, this year, some 1,300 exhibitors will share a building which is 1,885 ft. long × 470 ft. wide, whilst an outdoor display of structural and agricultural equipment, mining gear and contractors' plant will form an impressive display on a 3-acre site. The main groups shown indoors will be: (*a*) hardware, ironmongery and brass foundry; (*b*) building and heating; (*c*) electrical equipment; (*d*) engineering, metals, transport and gas. In the space available, no more than a brief indication can be given of the exhibits at Castle Bromwich which are likely to be of interest to those concerned with the production and use of metals in their various forms. In the following pages the exhibits are, in the main, classified according to their nature, the name of the exhibitor being given in the text, along with the stand number. Almost all the exhibits referred to will be found in Sections C and D in the Exhibition Hall, or on the Outdoor Stands. The numbers in parenthesis, following the exhibitor's name, refer to the location of the stand.

Wrought Steel

The main exhibit on the stand of ENGLISH STEEL CORPORATION, LTD. (D.541/438) will be a hollow forged high pressure boiler drum sectioned for inspection. It will be representative of the large forgings produced by the Corporation, some of which are so large that 250-ton ingots are required for their production. A range of crankshafts, press forged by the R.R. continuous grain-flow process will also be shown. All the advantages of a drop forging are claimed for this type of crankshaft which can be forged in sizes beyond the scope of any drop forge. Other products on show will include discs for jet engines, aircraft and commercial vehicle engine crankshafts, and springs and torsion bars, whilst research will be covered by demonstrations illustrating the transformation of steel when heated and cooled, the fatigue testing of steel samples, etc.

The story of the production of steel within the various works controlled by THE UNITED STEEL COMPANIES, LTD. will be told on Stand D.519/416 by means of enlarged coloured transparencies, which will show the manufacture of such diverse products as fine wire and steel railway wheels, together with the production of steel by the acid Bessemer, open-hearth and electric arc processes, and the subsequent cogging of the ingots. The main stress of the display will be laid on the production of

"Silver-Fox" stainless steels which will be shown in their many forms, finishes and uses. As usual, technical representatives will be in attendance throughout the exhibition to deal with visitors' queries.

The latest production development in the manufacture of corrosion and heat-resisting steels is the plant to be operated by Shepcote Lane Rolling Mills, Ltd., a joint Firth-Vickers-Samuel Fox project for the continuous production of stainless strip 1 metre wide in thicknesses from 10 S.W.G. to 30 S.W.G. This plant will be a great asset when production commences later this year. Shortage of nickel and the resultant scarcity of the austenitic chromium-nickel steels have led to their successful replacement by plain chromium steels in a number of instances. Each case must be decided on its merits and no doubt many problems of this type will be discussed on Stand D.419/318, where FIRTH-VICKERS STAINLESS STEELS, LTD. will be exhibiting corrosion- and heat-resisting steels in the form of sheet, bar, strip and castings.

One of the most interesting exhibits on the stand of EXORS. OF JAMES MILLS, LTD. (D.503/400) will be the model railway which will be in operation again this year: it will show models of the various types of Mills' track fastenings. The Aladdin rail and wheel flange lubricator for reducing wear on the curves of railway track will also be exhibited. The display will include a range of bright drawn steel bars (of which the Company are the largest makers outside the United States), and components made in Ledloy high-speed machining steel, together with keys, cotter pins, taper pins and Mills' patent grooved pins and studs.

Well known in the field of rolled steel products, LEE OF SHEFFIELD, LTD. (D.530) will be showing a selection of bright steel bars, cold-rolled steel strip, high grade steel wire, stainless steel strip and wire—all principal manufactures of the company — along with a selection of articles made from stainless steel.

The stand of THOS. W. WARD, LTD. (D.637/536) will be arranged to show the activities of the various companies of the group which include many branches of engineering, the supply of raw materials and the provision of various services to industry. Included in the products of the subsidiary companies are railway track and accessories; wrought iron sections, plates and forgings; plates, sheets, wire, etc., and diesel locomotives.

One side of Stand D.405/304 will be devoted to the products of BROCKHOUSE ENGINEERING (SOUTHPORT), LTD., while the remainder will feature selected products of other members of the BROCKHOUSE ORGANISATION, which includes forgings and rolled sections.

Stainless steel is a speciality of PADLEY & VENABLES, LTD. (D.525/422) and the exhibits will include sheet, strip, bars, tubes, sections, wire and castings, together with exhibits of manufactured articles produced from this material.

Attention is also drawn to the stands of RICHARD THOMAS & BALDWIN, LTD. (D.301/200), makers of a wide range of flat-rolled steel products and merchant mill products, DARWINS, LTD. (D.134), who specialise in tool steels and high quality alloy steels, and GUEST KEEN & NETTLEFOLDS (MIDLANDS), LTD., (B.629/526) who will be showing hot and cold rolled strip.

Ferrous Castings

An impressive centre piece to the DAVID BROWN stand (D.343/238) will be formed by a large fully machined cast steel tyre and trunnion made by DAVID BROWN-JACKSON, LTD. for a cement mill installation, whilst two notable examples of current production are among a selection of items exhibited on behalf of THE DAVID BROWN FOUNDRIES COMPANY. One is a 7-ton steel casting for a turbine half cylinder, whilst the other exemplifies the Company's post-war achievements in the production of castings for oilfield equipment. Other exhibits will include a range of sand, centrifugal, and precision castings in a number of materials.

On the EDGAR ALLEN stand (D.536), the steel foundry department's exhibit will include some large roller supporting brackets in toughened cast steel, two shipper shaft pinions in nickel-chromium steel and a third in nickel-chromium-molybdenum-manganese steel. As an example of complicated steel foundry work, a crawler truck frame for a large excavator will be shown, whilst smaller castings will include chain sprockets for excavators and cast steel slide clutches.

Reference has already been made, in the previous section, to the fact that stainless steel castings will be shown on the stands of FIRTH-VICKERS STAINLESS STEELS, LTD. (D.419/318) and PADLEY & VENABLES, LTD. (D.525/422).

The demands of the rearmament programme have meant the deferment of some developments proposed by HALE & HALE (TIPTON), LTD. to extend their wide range of castings, but the Company's stand (D.609/508) will feature many products recently introduced and indicating the extent to which industry is now using castings in blackheart malleable and in Permalite. Among them will be the Hale quick release shipbuilding wedge, developed from the Hewitt patent wedge release at the suggestion of a Clydeside shipbuilder who saw the release at the 1950 B.I.F. The display will include a wide range of castings produced for many industries, including mining, electricity, road and rail transport, shipbuilding, agricultural implements and machinery, and the building and allied trades.

At the time of going to press no details are available of the exhibits to be shown by JOHN HARPER & CO., LTD. of Willenhall, manufacturers of castings in grey iron and Meehanite. (Stand A.336)

Further examples of malleable iron castings will be displayed on the stand of LEY'S MALLEABLE CASTINGS CO., LTD. (D.513/410) indicating their use in the automobile, agricultural and general engineering trades. These castings are available in normal blackheart malleable and Lepaz pearlitic malleable.

On stand D.709, FOLLSAIN-WYCLIFFE FOUNDRIES, LTD. will be showing a range of heat-resisting articles in E.V. heat-resisting steel, Wynite heat-resisting cast iron or Penetral-treated mild steel. They will include carburising boxes, cyanide pots, firebars, pyrometer sheaths and furnace parts generally. Castings for ball mill lining, crusher lining, locomotive brake blocks and other abrasive duties will be shown in C.Y. erosion-resisting alloy, while the malleable iron castings will include the Wynip and Wyclip girder clips.

The selection of precision castings displayed by PRECISE CASTINGS on Stand A.327/226 will include gas turbine components in heat-resisting alloys, general engineering castings to replace forgings and parts machined from bar stock in low alloy steels, a selection of precision castings to illustrate their application to prototype work, stainless steel castings for small lathes,

stellite and other wear-resisting castings, and dentures in cobalt-chrome alloys.

NOduMAG will be shown for the first time by FERRANTI, LTD. on Stand C.615/514. It is a spheroidal graphite austenitic iron, which is virtually non-magnetic and soft though tough. The tensile strength is in the region of 18–26 tons/sq. in. with an elongation of 5–10%, whilst the B.S.S. 1349 impact test for grey iron invariably gives the maximum figure of 120 without fracture. Other high quality castings from the Ferranti foundry will also be shown.

Other manufacturers of ferrous castings who will be exhibiting include members of the BROCKHOUSE ORGANISATION whose stand is D.405/304.

Non-Ferrous Metals

Although the demand for copper far exceeds the available supplies, the COPPER DEVELOPMENT ASSOCIATION (D.232) is helping users to make their quotas go further, by choosing the right material, applied in the right way, avoiding waste and possible failure, and promoting efficiency and productivity. Display panels will show examples of the efficient use of copper and its alloys together with a few failures which could have been avoided by timely consultation. Members of the technical staff of C.D.A. will be available on the stand each day.

For many years THOMAS BOLTON & SONS, LTD. (D.518) have played a leading part in the development and manufacture of copper and its alloys for use in the electrical industry. Included in the exhibits will be "Combarloy," a special alloy for commutator segments, rail bonds for electric traction, 2- and 3-pole equaliser bars, rotor and stator end rings, H.C. bus-bars, wire and strip in copper, brass, and bronze, and trolley wire. Other exhibits will include tubes, extruded and drawn sections, machined parts and copper printing rollers for the textile trades. "Bush" brand chill-cast phosphor bronze solid and cored bars, and tungsten carbide drawing and extruding dies made from B.T.H. "Ardolov" complete the display.

In addition to general displays of sheet, strip, rod, extrusions, tubes, wire and fabricated metal sundries in copper, aluminium and their alloys, and specimens of condenser and locomotive firebox plates and copper rollers for textile printing, the METALS DIVISION of IMPERIAL CHEMICAL INDUSTRIES, LTD. will feature on Stand D.409/308 the many applications of the Division's wrought non-ferrous metals in building and transport, and the many-sided work of the Division's Research Department. The latter feature will include references to the Company's new Creep Test Research Station at Witton.

A selection of the enormous range of extruded shapes and sections made by MCKECHNIE BROTHERS, LTD., in various copper-base alloys will be seen on Stand D.315. There will be samples of extruded rods in high-strength bronzes, including Narrmac, an alloy developed for jet engine components. Other examples of their products on view will be hot stampings in brass, bronze and white metal; bronze and nickel-silver welding rods; brass wire; ingots of phosphor bronze, gunmetal, yellow metal, nickel silver, antifriction metal and Terne metal; chill-cast phosphor bronze bars; granulated cupro-nickel; and electrolytic copper.

Non-ferrous metals will also be shown on the stand of THE BIRMINGHAM BATTERY & METAL CO., LTD. (D.514),

7-ton turbine half-cylinder casting for a 60,000 kW turbo alternator.

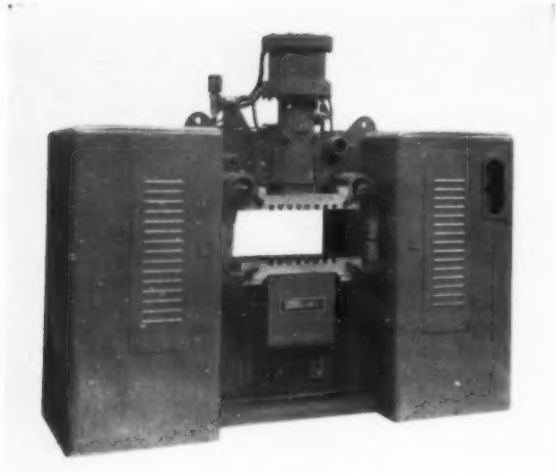
Courtesy of The David Brown Foundries Company

makers of sheets, plates, tubes, rods and wire in a variety of copper-base alloys, but precise details are not available at the time of going to press.

The basic products of LANGLEY ALLOYS, LTD. (D.404) are copper- and nickel-base alloys, and stainless steel castings. The most important of the copper alloys are the Hidurax aluminium bronzes and the Hidurel high conductivity alloys. Both these ranges are available as castings, forgings and bar; examples of the various forms will be on show, together with examples of applications. Other examples of copper alloys to be seen will include gun-metal castings, and castings and stampings in Hidurit manganese bronze, alloys which are also available as forgings and rolled bar. In the field of nickel alloys, castings in Monel, nickel and Inconel will be shown in addition to the corrosion-resisting Langalloy 'R' series of alloys. The exhibits will also include a display of valves which have been developed for corrosive service.

Specialists in the production of centrifugally and chill-cast bronzes, JOHN HOLROYD & CO., LTD. (D.210) will be displaying a range of finish machined bushes and gear blanks in their Spuncast Holfos Bronze, Super Holfos Bronze (both centrifugally cast), and Holfos Bronze (chill cast). Other exhibits will include a number of standard worm reduction and other gear units.

The pavilion on the stand of THE DELTA METAL CO., LTD. (D.311), is a testimony to the wearing properties of the Delta Bronze No. IV, of which it is constructed, for it has been a prominent feature of every exhibition in which the Company has participated since 1924, when it was first seen at Wembley. The exhibits will include a display of extruded sections, free-cutting brass rod, stamping rods, hollow extruded bars, welding rods, rolled strip and wire, and copper bars and shapes, together with examples of the cramps, dowels and the rods furnished in Delta Bronze No. IV for use in building construction and maintenance.



Courtesy of Sciaky Electric Welding Machines, Ltd.

Type P.A.D. 100 heavy duty projection welding machine.

Exhibitors showing non-ferrous castings will include C. & L. HILL, LTD. (D.616/717), whose display will include a selection of non-ferrous sand castings and chill-cast phosphor bronze bars; KAYE ALLOY CASTINGS, LTD. (D.405/304), makers of pressure and gravity die castings; and the UNIVERSAL ENGINEERING COMPANY (B.220), pressure and gravity die castings in aluminium and zinc-base alloys, and sand castings in aluminium alloys, gun-metal, brass, and other non-ferrous metals.

The stand of THE BRITISH ALUMINIUM CO., LTD. (D.605) will incorporate a mural illustrating a selection of the Company's products, but its primary purpose is to provide a meeting place for the Company's customers. No attempt will be made to demonstrate products on a large scale, but the stand will include reproductions of designs illustrating marine and structural engineering applications of aluminium.

Also in the light alloy field, ESSEX AERO, LTD., on Stand C.237, will be showing examples of castings and forgings in magnesium alloys, together with a wide range of mechanical and manual handling equipment fabricated in light alloys.

Welding and Cutting

The outstanding exhibit of SCIAKY ELECTRIC WELDING MACHINES, LTD., on Stand C.222, will be the recently developed heavy duty projection welding machine, Type P.A.D. 100, nominally rated at 100 kVA. The transformer arrangement is designed to give a high secondary current output for an economical mains loading, and the machine is equal in performance to the conventional 300 kVA machine. Large clearance for jigs and fixtures is afforded, and unloading of finished components is simplified as they can be ejected on the opposite side to the loading position, thus ensuring a steady flow, as in power press practice.

The range of resistance welding machines shown by HOLDEN & HUNT, LTD., on Stand C.719/620, will include rivet heaters, universal spot welders and butt wire welders, as usual, whilst a new feature will be a comprehensive display of electrode welding tips.

CYC-ARC, LTD. will be exhibiting their latest stud welding equipment on Stand C.218. The Type E.3 controller now embodies an improved electronic timer and provision is made for electrical interlocking, whereby two or three equipments can be operated from a single welding power supply unit. Improvements have also been made in the Type D hand tool and the Type F bench tool. In the last two years an extensive study has been made of the technique and metallurgy of stud welding ferrous and non-ferrous metals, more particularly in the group of aluminium alloys. Demonstrations will be given of stud-welding steel, brass and aluminium, and photographs showing varied applications of stud welding will be on view.

Part of the Owen Organisation, INVICTA ELECTRODES, LTD., will be exhibiting on the stand of the parent company, D.616/717, a range of electrodes and arc-welding equipment.

Oxy-acetylene welding and cutting have long been the concern of THE BRITISH OXYGEN CO., LTD., and the exhibits on Stand D.201/100 will show recent developments in these processes. A range of torches for welding and cutting will be displayed, together with rods and fluxes for welding, building-up and hard-facing work. Of particular interest is the recently modified 36-in. universal cutting machine which incorporates a number

Courtesy of The British Rollmakers Corporation, Ltd.

A group of Adamite alloy indefinite chill rolls for the finishing stand of a continuous hot strip mill.

of refinements, the more important being a new transmission, and a cutter designed for use with the B.O.C. one-piece nozzle. This last is particularly interesting as it enables the machine to be easily converted to powder cutting operation when profiling stainless steel. Demonstrations will be given of argonarc welding of copper, stainless steel, heat-resisting nickel alloys and alloys of aluminium and magnesium.

An entirely new oxygen profiling machine of the dual carriage type, with the burner adjustable over the full width of the machine and incorporating new circle and straight cutting devices, will be shown by HANCOCK & CO. (ENGINEERS), LTD. on Stand D.739/638. It can be fitted with all the standard drives, including the electronic, and additional burners for multiple cutting. Other exhibits will include an improved electronically controlled cutting machine; a U-arm machine for general work; the Circaline for cutting straights and circles; the Circalette—a lighter edition of the Circaline; a flame planer for plate edge preparation; and pipe and radial cutting machines. On the same stand, WELDCRAFT, LTD. will show their acetylene generators, welding rods, welding and cutting equipment and the "Fluxcraft" Gasfluxer.

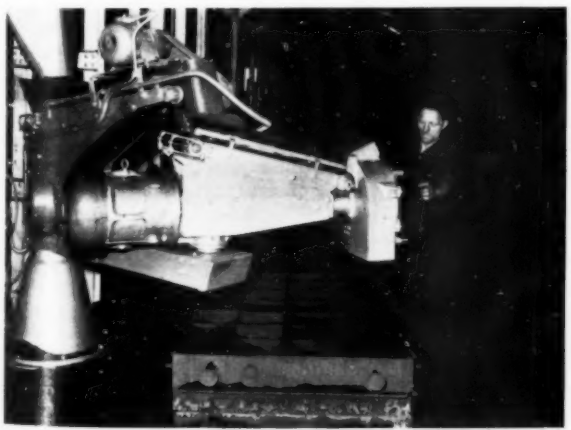
Stand D.224 will feature a wide range of holding tools and positioners made for the welding industry by DONALD ROSS & PARTNERS, LTD. These will range from the various types of Twinner vices and magnetic clamps to the electro-hydraulically controlled Model 99 positioner which is capable of taking a 3-ton load. Shown for the first time will be the new Twinner internal pipe aligners and pipe expanders, aids to the pipe-welding industry which will ensure perfect alignment of pipes from the inside for butt welding.

Rolls for Rolling Mills

The imposition of rigid specification for a rolled product in the ready-to-use and true-to-gauge condition, has necessitated rolls possessing the ideal surface structure, to suit a wide range of product, whilst the introduction of continuous rolling with the attendant changes in bearing design has led to radical revision of tolerance limits. The continued need for improvement has presented new and difficult problems to the roll maker. Such opposed characteristics as hardness and toughness, wear resistance and heat resistance, rigidity and flexibility, must be combined to give optimum results. A wide range of rolls will be exhibited by THE BRITISH ROLLMAKERS CORPORATION, LTD., on Stand D.517, together with photographs illustrating some of the largest rolls made for the rolling of plates. Plant used in roll manufacture will also be illustrated photographically, whilst for those interested in the metallographic structure of roll metals, a range of representative photomicrographs will be displayed.

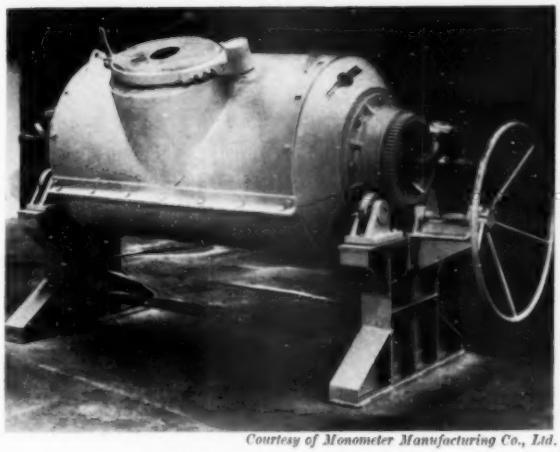
Foundry Plant

The stand of FOUNDRY EQUIPMENT, LTD. (D.427/326), manufacturers of a comprehensive range of equipment for iron, steel and non-ferrous foundries, will occupy some 75% more space than last year, when the Company first exhibited at the B.I.F. The exhibits will include a new "Major" sandrammer and the "Junior" sandrammer which was first shown last year. Both will be supplied with vertical skip loaders. The "Major" is designed particularly for the ramming of smaller moulding and core boxes up to about 4 ft. × 2 ft. 6 in., whereas the "Junior" will ram boxes up to 8 ft. × 4 ft. Other exhibits from the Foundry Equipment range will include a new batch-type sand mill of revolutionary design, and



Courtesy of Foundry Equipment, Ltd.

A "Junior" sandrammer.



Courtesy of Monometer Manufacturing Co., Ltd.

Semi-rotary melting furnace.

a new design of disintegrator or aerator which can be supplied in a fixed or portable form.

The main exhibit of THE FULLERS' EARTH UNION, LTD. (D.117) will be "Fulbond" for bonding foundry moulding sands. It is sometimes also used in core sands and sand test apparatus will be available to demonstrate the effect of "Fulbond" in various moulding sands, both silica and natural.

THOS. W. WARD, LTD., suppliers of a wide range of foundry equipment and materials, will be exhibiting on Stand D.637/536.

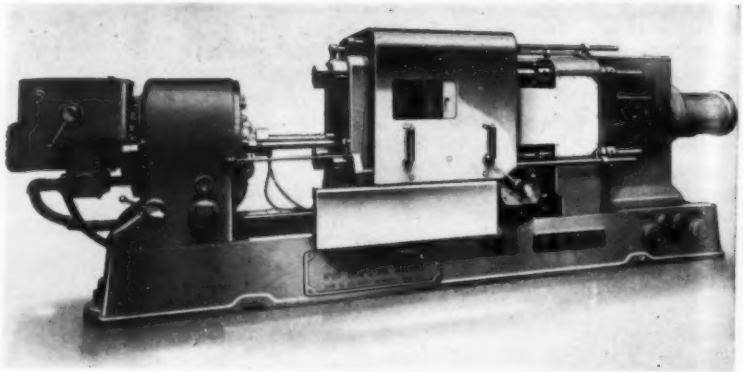
In addition to the widely known and used Salamander and Salamander Super plumbago crucibles, there will be a display of the new range of Salamander Suprex crucibles on the stand of THE MORGAN CRUCIBLE CO., LTD. (D.305/204). These crucibles designed for operations in specially arduous conditions, offer exceptional resistance to violent changes of temperature and give maximum resistance to erosive slags. Plumbago foundry accessories on show will include a display of launders, muffles, knock-off riser plates, moulds, stoppers and nozzles, tundishes, stirrers, skimmers and bricks and shapes for steel ladle and other linings. An interesting exhibit will be a nitrogen de-gassing apparatus incorporating a Salamander plumbago tube. Qualified technicians will be in attendance to advise on the use and installation of Morgan crucible furnaces.

Suitable for foundry and other uses, considerable interest will be found in the metal melting furnaces which will be shown by MONOMETER MANUFACTURING CO., LTD. on Stand D.731. These will include the latest design oil-fired fully-mechanised continuous rotary melting furnace, complete with retractable end flue, for melting ferrous and non-ferrous metals, and a semi-rotary oil- or gas-fired melting furnace for the melting of all non-ferrous metals, for ingoting and the production of foundry castings. Of particular interest will be the Wellworthy hydraulic tilting mobile truck ladle for supplying hot metal from bulk melting furnaces to bale-out furnaces, die casting machines or spinning machines. Handled entirely by one man, the whole is mounted on roller-bearing pneumatic-tyred wheels for ease of movement.

Melting furnaces for ferrous and non-ferrous metals will also be featured on the stand of LEES HALL & SONS, LTD. (D.112), whose display will include a central axis

Courtesy of Alfred Herbert, Ltd.

M55A/HF zinc type die-casting machine.



Courtesy of E.M.B. Co., Ltd.

No. 20 Diecaster fitted with cold chamber head for aluminium die casting.

tilting furnace, a tilting reverberatory refining furnace, and a complete rotary furnace of 1 ton copper capacity. There will also be on show examples of lift-out crucible furnaces, bale-out furnaces and pot-hole furnaces, whilst it is possible that a 2–3 ton cupola will be exhibited. Among the accessories will be heat-resisting iron crucibles, oil fuel burners, forced draught gas burners, heat-resisting fire bars, ingot moulds, oil fuel tanks and high and low pressure motorised fans.

Gas-heated appliances for the foundry featured on a section of the GAS COUNCIL stand (D.641/540) will include a drawer type core drying oven (F. J. BALLARD & Co., LTD.), fitted with flame failure devices and explosion relief panels, and an Acme Minor continuous vertical core stove (FOUNDRY AND ENGINEERING CO., LTD.). Other foundry equipment to be shown comprises a prototype crucible furnace making use of radiant burners, specially made by the EAST MIDLANDS GAS BOARD; a MORGAN bale-out crucible furnace; a mould dryer (MODERN FURNACES AND STOVES, LTD.) for use where dilution of the hot air with combustion products is possible; and torches for the skin drying of moulds (SELAS GAS AND ENGINEERING CO., LTD.).

In association with its two subsidiaries, STANDARD BRICK AND SAND CO., LTD. and JOSEPH BOAM, LTD., BRITISH INDUSTRIAL SAND, LTD. will be showing on Stand D.119 a full range of sands from their Redhill, King's Lynn and Mansfield quarries, together with an interesting display of articles in which sand is used either directly or indirectly in some manufacturing process.

For a long time the need has been felt for a single machine capable of casting zinc, aluminium or copper alloys, without having to make a major conversion of the changeover. With this as one of its main features, the E.M.B. Co., LTD. have designed their No. 20 Diecaster which will be sl own on Stand D.240. It is only necessary to break six unions and transpose the injection heads when making the change. The die-casting machine display by ALFRED HERBERT, LTD. (D.321/218) will feature the M.55A/HF zinc-type machine.

For the purpose of sand cleaning, foundrymen will be interested in the various types of magnetic separator shown on the stands of RAPID MAGNETIC MACHINES, LTD. (C.421) and ELECTROMAGNETS, LTD. (C.605).

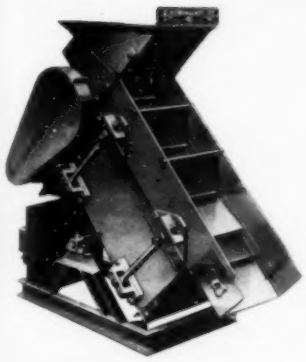
Tubes and Pipes

STEWARTS & LLOYDS, LTD., with subsidiary and associated companies, will again be exhibiting a wide range of their tube products. In the Engineering Group, a reception stand, D.511/408, staffed by representatives of the Company, will be at the service of visitors, for all enquiries relating to the exhibits and trade and technical matters generally. This stand will feature a section of a 72 in. sheathed and lined steel main, into which five panels have been inserted, each containing a colour transparency illustrating stages in the manufacture, protection and laying of large diameter steel mains; examples of coils and cold-rolled steel strip; and a range of high and low pressure manipulated steam pipework. The D Outdoor Stand comprises a steel building which will house a comprehensive range of the Company's products, including steel tubes and fittings, examples of protective linings and sheathings, tubular steel coils, hot and cold-rolled steel strip, foundry and basic pig irons, iron and steel castings, and steel and tube works by-products.

An interesting exhibit on Stand D.608 (AITON & Co., LTD.) will be a model in aluminium and Perspex, lent by I.C.I., Ltd., showing the turbine house pipework at their Wilton works. Other items on show will include examples of high and low pressure pipework; Corwell and butt-welded pipe joints; a cast-iron special pipe; bellows expansion joints and steam traps; whilst photographs will show the construction of a high-pressure steam receiver.

Material shortages restrict the display of SERCK TUBES, LTD. (D.618) to a colourful show of solid drawn tubing in copper and its alloys, in cut lengths. On the same stand, SERCK RADIATORS, LTD. will join in a display of heat exchange units.

No details are to hand at the time of going to press concerning the exhibits of the YORKSHIRE COPPER WORKS, LTD., but, no doubt, a wide range of non-ferrous tubing, in which the company specialises, will be displayed on Stand B.723/634.

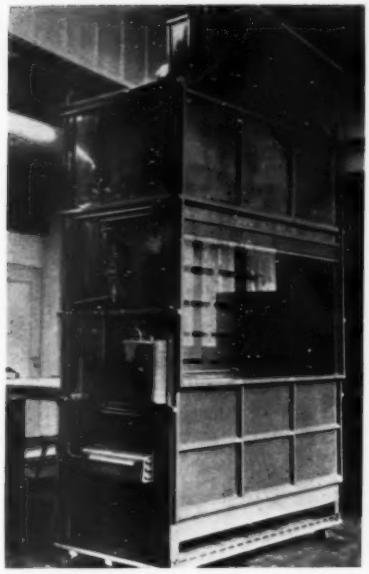


Courtesy of Electromagnets, Ltd.

High intensity heavy duty agitated chute separator of the electro-magnetic type.

Courtesy of W. Canning & Co., Ltd.

Canning dome polishing machine.



Courtesy of The Hockley Chemical Co., Ltd

Colasit acid fume extracting and neutralising chamber.

Wire

THE LONDON ELECTRIC WIRE COMPANY AND SMITHS LTD., and its Associated Companies, FREDERICK SMITH & COMPANY, THE LIVERPOOL ELECTRIC CABLE CO., LTD., and VACTITE WIRE CO., LTD., will display bare and insulated conductors for all electrical purposes on Stand C.717. These include the well-known "Lewcos" products—cotton, silk, paper, enamel, Lewmex, Lewmexglass and Lewbestos insulated wires and strips; "Anacos" bare copper and copper alloy wires, strips, strand, sections and forgings; power-transmission lines, trolley wires and telegraph and telephone line wires; L.E.C. rubber and paper insulated cables for use in mines, quarries, ships, factories, railways; underground power cables, and domestic flexibles. Eureka and Vacrom resistance wires and tapes, molybdenum rods, wires and tapes, and special wires for the lamp and radio-valve industries will also be on view.

"Tectic" brand oil-tempered spring wire, produced by a delicately controlled process will be stressed in the display on Stand D.607, where JOHN RIGBY & SONS, LTD. will be exhibiting an extensive range of high and low carbon steel wires and precision drawn sections and pinion rods in steel, brass and nickel silver.

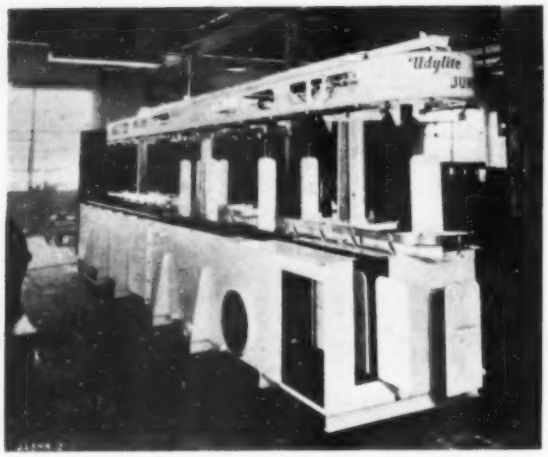
Other firms displaying wire and wire products will include LEE OF SHEFFIELD, LTD. (D.530) who will be showing high-grade steel wire and stainless steel wire; PADLEY & VENABLES, LTD. (Stand D.525/422), stainless steel wire; RICHARD JOHNSON & NEPHEW, LTD. (Stand B.417/322), ferrous and non-ferrous wires; RYLANDS BROS., LTD., WARRINGTON (Stand A.528), ferrous and non-ferrous wires, fencing, nails and various wire products; THE WHITECROSS CO., LTD. (Stand A.518), industrial and agricultural wires, both ferrous and non-ferrous wire products and wire ropes for mining, shipping and engineering purposes.

Electroplating

Visitors to the FESCOL stand (D.652) will get a clear idea of the way in which Fescolising is used to renew worn parts and prolong the working life of new components. Two large hydraulic rams will be shown; one in a badly-corroded condition before being Fescolised, and the other after treatment. In contrast, there will be a display of small work handled by the Company, including spindles for electric clock units Fescolised in chromium. Mural photographs will illustrate large plants in various industries where the Fescol process has been applied to advantage.

A number of items of plating equipment will be shown by W. CANNING & CO., LTD. on Stand D.207/108. These will include a Hector totally submerged plating barrel, which is specially designed for handling large loads and may be used for the deposition of most metals other than chromium; the latest Canning chrome barrel which can be easily converted from batch plating to continuous operation by the purchase of a suitable barrel and fittings, change-over being effected in a few minutes; Rotunda filter units; Tynee portable filter units designed to meet the needs of small capacity plating plants; a bottom-emptying centrifugal drier; and Canning centrifugal lacquering machines. Other exhibits will include rectifiers, control panels and a comprehensive selection of materials such as plating salts, lacquers, and finishing materials generally. On Stand D.211, the polishing equipment division of the same Company will be showing a centreless abrasive band machine; a semi-automatic machine for polishing dome-shaped articles; a profile attachment for polishing irregular shapes; a number of polishing heads; and a comprehensive range of polishing mops, brushes and materials for the finishing of metals.

Considerable interest will be aroused by the exhibition on Stand C.611 (ELECTRO CHEMICAL ENGINEERING CO., LTD.) of an Efco-Udylite "Junior" fully-automatic plating machine, actually in production. The process in use will be the Efco-Udylite bright zinc process on steel parts, which is being increasingly used as an alternative finish to bright nickel. The new Efco-Udylite equipment for automatically loading and unloading racks of work



Courtesy of Electro-Chemical Engineering Co., Ltd.

Efco-Udylite Junior fully-automatic plating plant.

from the rack conveyor on to and from the plating machine will also be demonstrated, and samples plated with the Efco-Udylite bright copper and white brass processes will be on view.

An exhibit of outstanding interest on the stand of R. CRUICKSHANK, LTD. (D.226) is the new P.R. copper-plating process which has a cyanide bath and uses the principle of periods of current reversal, controlled by a timing unit. The deposit is bright, hard, ductile and pore-free, and can be used as an undercoat for chromium with or without a nickel flash: the process is also suitable for electro-forming. A further process, the Efco-Udylite bright zinc process, will also be shown, whilst exhibits on the plant side will include plating equipment, centrifuges, polishing machines, mops, brushes and polishing compositions.

Equipment and materials for electro plating and metal processing will be shown by THE HOCKLEY CHEMICAL CO., LTD. on Stand D.215. The main exhibit, which will be on show for the first time in this country, will be the Colasit acid fume extracting and neutralising cabinet used in connection with acid pickling processes on metals where harmful and corrosive fumes are evolved. The Colasit process enables all such fumes to be destroyed completely, permitting operation of the cabinets anywhere in the works, the discharge being completely neutral and absolutely free from toxic fumes. A photo-electric cell, activated by the density of fumes given off, controls the distributor which regulates the supply of ammonia, so controlling the neutraliser. Coupled to this photo-electric device is a magnetic valve which feeds neutralising solution into the waste-water pipeline.

Of particular interest to the plating trade, on Stand D.434 will be a display by GIRDLESTONE PUMPS, LTD., of diaphragm pumps for corrosive and abrasive fluids.

Other Surface Treatments

Metal spraying equipment and applications of the process will be featured by METALLISATION, LTD. (Outdoor 1348), although details of the particular exhibits to be shown are not available at the time of going to press. The Company will also demonstrate the process on the GAS COUNCIL stand (D.641/540).

Examples of architectural ironwork, rust-proofed by the sherardising process (coating with zinc by heating in zinc powder) will be displayed on Stand B.724 by the ZINC ALLOY RUST-PROOFING CO., LTD. The Company does not manufacture architectural ironwork but specialises in carrying out sherardising for the makers of casements, metal trim, screws, nails, etc.

A similar process in which aluminium powder is used instead of zinc, is calorising. The virtue of this treatment is the high degree of scale-resistance conferred on steel parts thereby and on Stand D.407/306, THE CALORISING CORPORATION OF GREAT BRITAIN, LTD., will be exhibiting calorised solid pressed steel heat treatment containers for cyanide, salt, lead, casehardening and annealing, together with pyrometer sheaths, air heater tubes, etc.

Originally designed for rapidly emptying hot fluid spelter from a galvanizing bath, the T.B. vertical pump to be shown by THOMPSON BROTHERS (BILSTON), LTD. on Stand D.637 has wider applications and is serviceable where low-melting point metals have to be handled in bulk. Another Thompson exhibit, namely the direct drive centrifugal machine, has applications in the galvanizing field where it is used for the removal of surplus zinc from hot-dipped parts. An essential feature of the machine is the minimum of time lag between withdrawal of the basket from the coating bath and spinning.

On the FOLLSAIN-WYCLIFFE stand (D.709) will be exhibited examples of carburising boxes, etc., made in mild steel and Penetral treated to render them resistant to oxidation at temperatures up to 1,000° C.

The extra space on the JENOLITE stand (B.221) this year will be devoted to examples of the increasing range of industrial products being pretreated by Jenolite processes. Among the Jenolite products shown will be the Jenolite A.C.I. Aluminium Cleaner and Degreaser, which has no fire hazard, no toxic fumes and does not attack aluminium. Jenolite R.R.N.I. Rust Remover Neutralizer has undergone progressive development during the year and a Jenolite Chemical Sealer developed which, by combining with surplus R.R.N.I., provides an additional corrosion-resisting coat. Other products on show will include Jenolite Black Finish and Jenolite Soldering Solution.

Processes for finishing, colouring and protecting metal components will be featured by METAL PROCESSES, LTD. on Stand D.229, and besides the finished components displayed there will be demonstrations in operation of Niklit, Mark II Black, S.G., Blass Blazic, Blazal and other processes. The Niklit process gives an attractive imitation white nickel finish to articles made in copper-base alloys by simple immersion, and without the use of nickel. There will also be exhibited chemical plant, tanks and welded steel fabrications.

On Stand D.242, THE WALTERISATION CO., LTD. will be exhibiting industrial products showing the value of using Walterisation to prevent rust, Foscote (R.S.) to destroy rust, and Deran to dissolve rust, whilst a colour film with sound commentary will illustrate the processes in practice. A demonstration of the cold brush-on rust-destroying Foscote R.S. will be given, along with Foscote A.L., a pretreatment for aluminium prior to painting, and Foscote G.A. for the pretreatment of galvanised and other zinc surfaces to secure effective adhesion of paint. Samples will also be shown illustrating the Walterisation L process, an A.I.D. approved alkaline-chromate oxidation treatment for aluminium and certain of its alloys.

In order to obtain effective rust protection of iron and steel, it is essential for the corroded surface to be thoroughly cleaned and freed from rust and scale prior to painting. A further product developed for this purpose, Ferro-Betol, will be shown by FERRO-BETOL, LTD. on Stand B.207.

Furnaces and Refractories

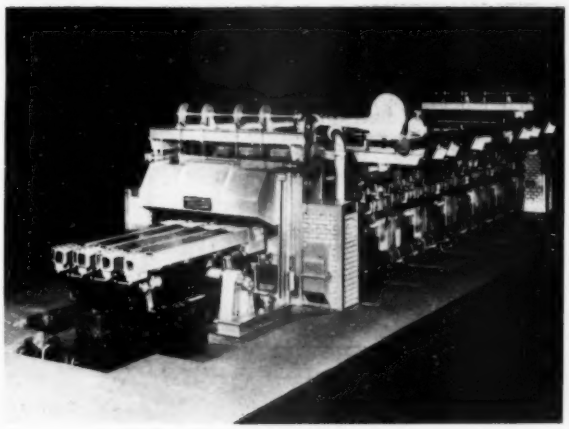
A section of the GAS COUNCIL stand (D.641/540) will be devoted to a display of gas-fired furnaces for use in the metal industries. For high-temperature operation there will be a Cyclone forge furnace (THERMIC EQUIPMENT & ENGINEERING CO., LTD.) and a muffle furnace designed for use with low pressure gas (SELAS GAS & ENGINEERING CO., LTD.) both for use at temperatures up to 1,250° C. Medium temperature equipment will include a portable cover annealing furnace (THE DOWSON & MASON GAS PLANT CO., LTD.), of the type originally developed for sheet annealing and subsequently adapted for annealing of steel and iron castings, heat treating forged steel rolls and malleabilising, and a natural draught furnace (INCANDESCENT HEAT CO., LTD.) suitable for various heat-treatment operations between 600° and 1,000° C. The display will be completed by a gas-fired salt bath furnace (BRAYSHAW FURNACES & TOOLS, LTD.), for operation at temperatures up to 900° C., and a forced air circulation oven (J.L.S. ENGINEERING CO., LTD.) in which no combustion products enter the working chamber.

A problem experienced by THE INCANDESCENT GROUP at past exhibitions has been the difficulty of putting over their great range of equipment in the space available. This year, on Stand C.727/628, scale models of typical installations will be displayed. THE INCANDESCENT HEAT CO., LTD. will be represented by: (1) a producer gas-fired balanced hearth walking beam furnace; (2) a gas-fired radiant tube refractory roller hearth furnace; (3) a complete heat-treatment installation, including recuperative furnaces, mechanised quench tanks, etc. (working model); (4) twin Whiting cupolas; and (5) a Hi-Nitrogen generator. A continuous drum spraying and drying plant will represent CONTROLLED HEAT & AIR, LTD., and a three-phase swing-roof tilting arc furnace for steel melting METALECTRIC FURNACES, LTD. The products of SELAS GAS & ENGINEERING CO., LTD. (not models) will form a display of gas and oil burners, mixing apparatus, and bench-type muffle furnaces, whilst METAL PORCELAINS, LTD. will be exhibiting finished vitreous enamelled samples. THOMPSON L'HOSPIED & CO., LTD. is the member of the Group supplying heat-resisting alloy castings for internal use and outside sales.

A 25-kW. induction heater will be exhibited by THE ENGLISH ELECTRIC CO., LTD. on Stand C.613/512. This is a robust and highly versatile machine for use in the production line, and is believed to be the most powerful high-frequency heater using a single air-blast cooled oscillator valve. Facilities are available to enable applicators, work-handling gear or jigs to be mounted directly on the equipment, and electrical and mechanical interlocks are provided for the protection of personnel.

Induction heating will also be featured on the stand of THE BRITISH THOMSON-HOUSTON CO., LTD. (C.511/410), where a 25-kW high-frequency induction heater will be seen demonstrating the hardening of tool steel.

For the pulverised fuel firing of furnaces, ALFRED HERBERT, LTD. (D.321/218) will be showing their latest



Courtesy of The Incandescent Heat Co., Ltd.

Working model of a walking beam furnace.

Atritor unit pulverising, grinding and drying machine, and various types of gas burner, including the Aeromatic gas injector, will be exhibited by the AEROMATIC CO., LTD. on Stand D.542, whilst carburising boxes, pyrometer sheaths and other furnace parts in E.V. heat-resisting steel, in Wynite heat-resisting cast iron, or in Penetral-treated mild steel will be displayed on Stand D.709 by FOLLSAIN WYCLIFFE FOUNDRIES, LTD.

Similar heat-treatment equipment, in calorised mild steel, will be shown by THE CALORISING CORPORATION OF GREAT BRITAIN, LTD. on Stand D.407/306.

On the refractories side, the display of JOHN G. STEIN & CO., LTD., on Stand D.313, will consist essentially of samples of bricks from their extensive range. This will include silica bricks for open-hearth purposes, both of normal quality and Super Duty; fire bricks ranging in alumina content from 32–44%; high alumina bricks containing 50–90% alumina, and including special bricks such as Stein Mullite (73% alumina), and Stein Sillimanite (62% alumina); and basic refractories, including straight magnesite, chrome magnesite and chrome. Also on show will be samples of refractory cements and of ramming and casting refractories.

A range of P.B. SILLIMANITE refractories will be shown on Stand C.622, the various brick shapes being representative of the many purposes for which such bricks are used. The usual ramming mixtures for the lining of metallurgical furnaces will be exhibited, together with coating processes for the protection of refractory and insulating bricks, refractory cements and patching mixtures. Tubes and crucibles of various types will be included in the range of laboratory ware on show, and the display will be completed by a representative range of refractories made by the newer ethyl-silicate bonding process.

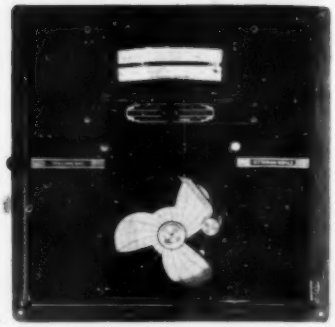
The refractories section of Stand D.305/204 (THE MORGAN CRUCIBLE CO., LTD.) will show the wide diversity of shapes and materials available. Special attention will be devoted to the new refractory, Morgan M.R.1., which is rigid at a temperature of 1,600° C. and is recommended for applications where firebrick has to stand severe operating conditions. The range of refractory bricks will include a selection of grades for use in heat-treatment furnaces, boiler settings, oil stills, steel ladles, etc., made by Morgan's associates, THE DOUGLAS FIREBRICK CO., LTD. Attention will also be directed to

Courtesy of Kelvin & Hughes (Industrial), Ltd.

Flue gas analysis lossmeter.

Courtesy of Elliott Brothers (London), Ltd.

Elliott O-type temperature controller.



Courtesy of Ether, Ltd.

Ether-Wheelco Chronotrol programme controller.

Triangle laboratory ware, pyrometer sheaths, electric furnace crucibles, and pure oxide ware. Of special interest will be the display of Carblox corrugated hearth blocks and standard shapes for blast furnaces.

Graphite electrodes for electric furnace operation, graphite anodes for electrolytic cell operation and amorphous carbon electrodes for electric arc furnace operation, will be among the exhibits featured by BRITISH ACHESON ELECTRODES, LTD., on Stand C.416. Others will include carbon blocks for furnace linings, crucibles, blocks, resistor spirals, mould stool inserts for metallurgical work and a number of other examples of the use of graphite in chemical and electrical work.

On the stand of J. H. SANKEY & Co., LTD. (B.405), Pyruma, Siluma and Aluma fire cement will be displayed along with Sankey's super acid-resisting cement, and various types of fire bricks and acid-resisting bricks, whilst on Stand D.161, PURIMACHOS, LTD. will be showing their plastic fire cements and, for very high temperatures, their Alukos and Drykos powder fire cements, for setting and repairing, and as a wash for furnace brickwork.

Temperature Measurement and Control

This year, the ETHER exhibit on Stand C.700 will feature new electronically-operated instruments with high accuracy and speed of response, designed mainly for temperature measurement and control. The Ether electronic potentiometric controller which incorporates the Ether-Wheelco Capacitrol as the controlling element, has given satisfactory service in the control of creep-testing furnaces, and the Ether Widestrip potentiometer, with a time of travel across a 10 in. chart of 2 seconds, is suitable for the measurement of a number of physical values. These instruments will be shown, together with a range of Ether-Wheelco Capacitrol electronic indicating controllers giving on-off, multi-stage and fully proportional control, supplemented by the Capaciline and Xactline devices for anticipatory control. Where rapid temperature readings have to be taken, such as with molten steel or billet temperatures, there will be shown a photo-cell D.C. amplifier working in conjunction with a high-speed recorder and a 16 in. dial indicator, whilst predetermined heating and cooling cycles are catered for by the Ether Chronotrol programme control unit. The exhibit will be completed by a display of molten metal pyrometers, surface pyrometers, optical pyrometers, Ether Indicorder continuous chart recording pyrometers and combustion safeguard devices.

The outstanding exhibit of the process control equipment displayed on the stand of ELLIOTT BROTHERS (LONDON), LTD. (C.320) will be a section of a large and comprehensive instrument installation for automatic control of furnace temperature for the continuous weld tube mills at Stewarts & Lloyds, Ltd., Corby. The furnaces are producer-gas and oil-fired and the instrumentation demonstrates the versatility of the Elliottrol Trimode controller and associated equipment which is used for automatic control of fuel flow, air-fuel ratio and recuperator temperature. Of particular interest will be safety devices incorporated in the installation. Systems for industrial temperature measurement and control will include thermo-electric pyrometers and indicators, electrical distance thermometers, total radiation pyrometers, optical pyrometers and a simple on-off controller. Of topical interest will be Elliott instrumentation for fuel economy, which includes CO_2 indicators and recorders, flow meters, temperature indicators and standard unit instrument panels for the boiler house.

Tem-Con, a temperature control system developed by P.A.M., LTD., will be demonstrated on the stand of the parent company, THE SOUTHERN AREAS ELECTRIC CORPORATION, LTD. (C.505), with reference to an investigation of the problems of temperature control in plastics extruders. Part of the stand will be shared with HUMIDITY CONTROL, LTD., who will be showing the Humijet unit humidifier, to which Tem-Con control is fitted as a standard.

On the KELVIN & HUGHES stand (D.626), there will be exhibited an entirely new electronic controller range, specially designed to facilitate a variation of control system by a minimum change of components. Two-position, proportional or compound control can be obtained for use with either resistance thermometer or thermo-couple measuring systems. The basic controller is supplied in two types, either for manual setting of the control point or as a programme controller. In the event of power supply failure, valve filament failure, low valve emission or broken thermocouples, a new Mark 3 controller range, which embodies many improvements in engineering design, automatically switches external apparatus to the " off " position.

INDUSTRIAL PYROMETER CO., LTD. (C.716) will be exhibiting a full range of industrial pyrometers, comprising edgewise indicators, portable indicators, foundry indicators, rotary switches, rotary switch indicators, indicating controllers, single and multipoint, recorders and recording controllers. Most of these are produced in a number of sizes to be in keeping with the size and cost of process plant.

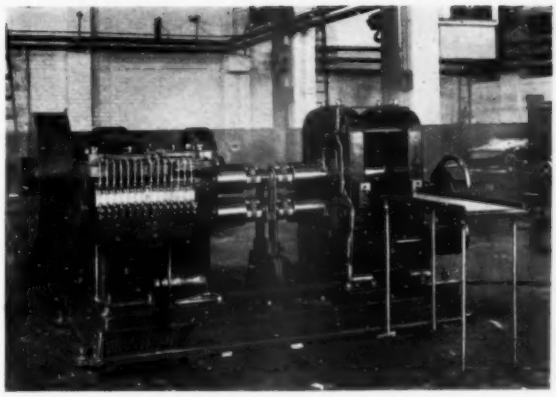
For the purposes of remote indication, the "Desynn" system shown by SMITHS INDUSTRIAL INSTRUMENTS, LTD., on Stand D.727, will be of interest. The transmitter and indicator are connected electrically and distant indication of pressure, displacement, temperature, fluid level, etc., is possible by this means.

Occupying their usual stand (C.722), LONDEX, LTD., will present their range of relays, contactors, process timers, level and flow controllers, photo-electric equipment, and pressure and vacuum switches.

A comprehensive range of domestic and industrial temperature control equipment will be shown by the RHEOSTATIC CO., LTD. (C.500), including thermostats, gas valves and gas safety devices.

Machine Tools

Although the machine tool trade will be holding its own exhibition later in the year, there will be several items of equipment of interest to the metal working trade on show at the B.I.F. SIR JAMES FARMER NORTON & CO., LTD., will be showing, on Stand D.167, a selection from their wide range of products in the metal production machinery field. The No. 3 bar straightening or reeling machine is one of a range which will handle bars up to 3½ in. diameter mild steel, or 4 in. diameter non-ferrous material, whilst the 4 in. centreless bar turning machine is one of a range of machines used for producing bright turned bar on a large scale, in diameters varying between ½ in. and 9 in. On the wire drawing side, the latest model of the TF3A machine, with a special built-in spooling apparatus, will be shown in operation. The rotary swaging machine to be exhibited is of the inverted type and embodies certain novel features, and this machine will also be shown in operation, to demonstrate the absence of noise. This year, a new type of vertical stranding and vertical closing machine, on which speeds of some 6,000 r.p.m. are obtainable, will be exhibited. This is essentially for fine rope wires, but larger prototypes are under construction at the works. On the same stand, ANGLARDIA, LTD., will be exhibiting a selection of their tungsten carbide and diamond impregnated products, whilst WIRE DRAWING DIES (MANCHESTER), LTD., will display a range of diamond dies, tungsten carbide dies, a selection of blocks and mandrels, and tungsten carbide faced rollers for the flattening of wire and strip.

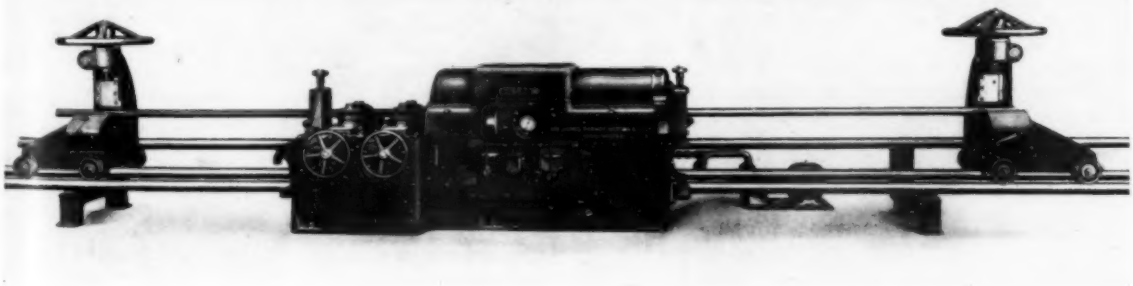


Courtesy of Taylor & Challen, Ltd.

10-in. fillet rolling mill.

A 14-in. diameter fillet rolling mill, suitable for use in mints for breaking down and thinning gold, silver, bronze and nickel fillets and strips, will be shown by TAYLOR & CHALLEN, LTD., on Stand D.415. The roll faces are 16 in. wide and the mill rolls fillets up to 2 in. thick, at a speed of 120 ft./min. For deep-drawing articles in sheet steel, brass or aluminium, there will be shown a double-action drawing press (size 3½) which will admit a blank up to 14 in. diameter and will draw a cup up to 10 in. diameter and 2½ in. deep, or 5½ in. diameter and 5 in. deep. A 20-ton capacity single-action press, Type 1220, to be shown, is a standard light press used for a variety of operations, and is inclinable by hand to a maximum angle of 45°. An operator's guard is fitted and coupled to a patent safety brake gear.

TURNER BROTHERS (BIRMINGHAM), LTD., makers of press tools, jigs and fixtures, and of saw tooth notching machines, will have three of their presses on show on Stand D512. There will be a TBG 315, 15-ton, geared inclinable power press, suitable for drawing operations and blanking in thick material; a TB26, 6-ton, standard fixed stroke inclinable power press, suitable for all standard press operations such as blanking, piercing, raising, forming, etc., in light gauge material; and the TBG 425, 25-ton, geared standard 4 in. stroke inclinable power press, suitable for drawing and cupping operations



Courtesy of Sir James Farmer Norton & Co., Ltd.

4-in. centreless bar turning machine.

Courtesy of Thos. W. Ward, Ltd.

Portable alligator shear from the Eldair range of metal working machines.

and for work in thick material. Other exhibits will include a range of pressings, die castings and plastic articles manufactured from Turner tools.

A No. 225A gang slitting machine, designed to slit tinplate sheets up to a maximum thickness of 0·025 in. into strips with extreme accuracy, will be featured on Stand D.603 (E. W. Bliss (England), Ltd.), where there will also be exhibited a No. 322N automatic can body maker which is an all crank machine producing round, square or irregular-shaped can bodies at high speed. From the range of 13 standard sizes, having capacities up to 115 tons, Bliss will be exhibiting a No. 19B, 15-ton, inclinable power press, whilst for small blanking, forming and assembling work, Nos. 8 and 12 bench presses will be shown. The latter can replace hand-operated fly presses, reducing operator fatigue and giving a much higher output.

From the range of Oilaulic presses made by John Mills & Co. (Llanidloes), Ltd., three have been selected for showing on D.337. They are the 6-ton standard bench press, suitable for a number of applications in fitting and assembly shops, etc., the 30-ton standard vertical press and the 30-ton standard vertical forcing press which is particularly useful for the fitting of gears and pulleys to shafts. The essential power unit of all these presses is the Mills Oilaulic Pump, which is a combination of a multi-ram high pressure unit and low pressure rotor. These provide two speeds to the ram—a rapid approach which changes automatically to the working speed when the ram contacts the work.

The open-throat downstroking press, for arboring, assembly, straightening, etc., of machine parts, to be shown by Finney Presses, Ltd., on Stand D.243, is one of a series of four ranging from 15 to 100 tons capacity. They are completely self-contained units incorporating Finney hydraulic equipment which includes a hydro-pneumatic accumulator. Also featured will be a 100-ton transfer stroke compression moulding press, together with a range of hydraulic pumps, valves, etc., which will include the Greer-Mercier hydro-pneumatic accumulator, manufactured under licence by Finney Presses, Ltd.

As representative of their range of presses, Hordern, Mason & Edwards, Ltd., will be exhibiting the D.C.P.5 press, on Stand D.500. This is a single action motorised double crank machine, designed for heavy blanking and piercing, raising, forming, planishing, etc., and the variable stroke enables the press to meet all kinds of operations under the most favourable conditions.

J. P. Udal have specialised in the guarding of power and hydraulic presses for many years, and on Stand D.630 they will be showing examples of the Fastrip series of guards on typical presses. Most will incorporate the positive arrester which is designed to open the guard as the press crank passes bottom dead centre, thus increasing production rates. A display of photographs will illustrate Udal guards on large presses, such as those used in motor car body production.

The new machines exhibited by F. J. Edwards, Ltd., on Stand D.411 will include five of interest to engineers and sheet metal workers. They are: a production press brake; a heavy double geared universal swing-beam folding machine; a shearing, section cropping and notching machine; a wheeling and raising machine; and 36½ in. × 2 in. production bending rolls. In addition to the new machines, there will be a comprehensive display of Besco metal working machinery which will include presses, guillotines, folding machines, and sheet metal workers' hand tools.

British built U.S. press shop equipment, designed to reduce manual handling of material, resulting in increased output and better products, will form the display on Stand D.159 (Rockwell Machine Tool Co., Ltd.). Of special interest will be an automatic coil cradle of new design which can handle coils up to 20 in. wide and having a maximum outside diameter of 48 in. The coil is merely rolled into position, when it is picked up and raised to the required level by power operated lifting mechanism. Another new development is the Multi-Stop, a safety device to protect dies and tools by stopping the machine should the material buckle or run out. Other equipment will be shown individually and in the form of an automatic unit comprising press, slide feed, automatic unwinding reel and stock straightener, stock oiler and scrap cutter.

All the metal cutting machines on the stand of The Midland Saw and Tool Co., Ltd. (B.228), will be available for demonstration. They will include an ATC toolroom bandsaw with saw welder incorporated; an AT toolroom bandsaw with saw brazer incorporated; a 36 in. variable high-speed bandsaw for sheet metal; an overhead cut-off machine for aluminium extruded sections; a 36 in., 8-speed bandsaw for cutting aluminium bronze, phosphor bronze, gun metal, brass and aluminium alloys; and an electric butt welding unit for saws up to 1 in. wide.

Certain of the lines marketed by the Machinery Division of Thos. W. Ward, Ltd., will be shown in operation on Stand D.637/536, notably the Eldair range of sheet metal manipulating machines, including guillotine, press brake and shears—the latter being of the portable type, both electrically and diesel engine driven.

On Stand D.632, an improved model of the Pullomax plate cutting machine, with a complete range of tools for straight and circle cutting, beading and folding sheet metal up to 7/32 in. thick, will be shown by George H. Alexander Machinery, Ltd.

Specialists in machines for breaking, crushing, pulverising and grinding friable material, British Jeffrey-Diamond, Ltd. (D.528), intend to display a selection of machines from current production that will be representative of the B.J-D. range. They will include a 15 in. × 15 in. single roll breaker; a 24 in. × 20 in. Flextooth

crusher; a 20 in. × 12 in. swing hammer pulveriser; a 15 in. × 8 in. Atomill fine grinder; a 10 in. × 5 in. Intermediate Atomill; and a B.J-D. Microid Atomill.

Showing for the first time on the EDGAR ALLEN stand (D.536) will be a 24 in. diameter circular saw which has proved exceptionally successful in the sawing of magnesium and aluminium alloys at the Nuneaton works of Sterling Metals, Ltd. Working on magnesium, this saw cuts about 160 castings a day and the saw runs for about 10 days between regrinds. On aluminium, the saw has proved equally successful, and bids fair to revolutionise production problems on this material.

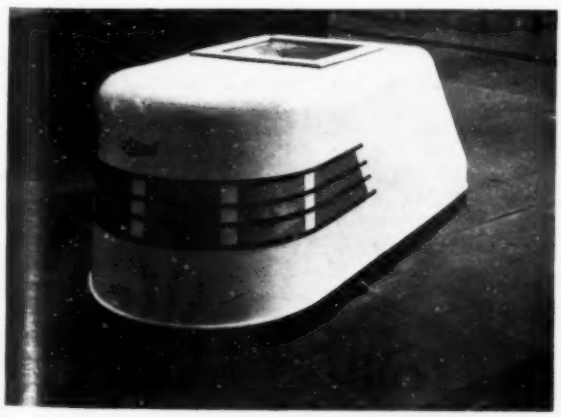
Small Tools and Tool Steels

The products of the Openshaw works of ENGLISH STEEL CORPORATION, LTD., shown on D.541/438, will include a comprehensive display of engineers' tools, including twist drills, reamers (solid and expanding), taps, dies and chasers, gear cutters, hobs, broaches, milling cutters, side and face and slotting cutters, end mills, slot drills, quick change chucks, lathe tools and boring cutters, chisels and rivet snaps, files and rasps, and hacksaws.

Owing to limitation of space on Stand C.319, HALL & PICKLES, LTD. are confining their display to a small selection of their special Hydra tools, which are made from their own Double-Super-Hydra or Super-Hydra high-speed steels. These tools will include a large form-relieved profiling cutter, one of a pair for machining the front and back faces of large steam turbine blades, and two large special-purpose reamers. The remaining tools include a small gear hob and examples of circular, flat and tangential form tools.

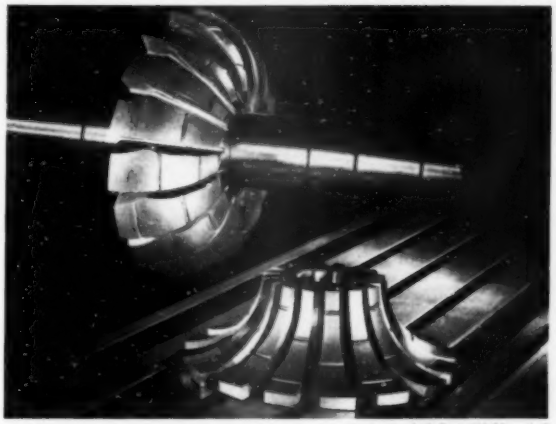
The major part of Stand D.234 (RICHARD W. CARR & CO., LTD.) will be devoted to a display of a range of Motor Brand fine tool steels shown in the form of finished tools loaned by customers. The steels illustrated by these tools are suitable for plastic moulding, die-casting, hot extrusion, impact extrusion, punching, pressing, clipping, drawing, thread rolling, and for production tools such as gauges, collets, taps, drills, cutters, reamers, hobs, etc. In addition, there will be a selection of Motor Brand engineers' small tools.

EDGAR ALLEN & CO., LTD. (D.536) will have on show a range of steels for dies working on aluminium, copper-base alloys, etc., together with actual finished dies. A



Courtesy of British Jeffrey-Diamond, Ltd.

10 × 5 in. intermediate Atomill.



Courtesy of Hall & Pickles, Ltd.

Pair of turbine blade cutters.

display of small tools will include standard, form-ground and hand-ground special Stag Major Superweld butt-welded tools, high-speed tools of various form-ground special types, and Athyweld deposit-welded tools, the principal items being roll turners' tools in 10–12% cobalt steel having a minimum Rockwell hardness of C.65, and form tools in the same material. There will also be a range of Stag Major high-speed steel tool-holder bits, Stag Major special design taper shank twist drills for drilling manganese and high tensile steels and 18% tungsten jobbers and taper shank drills.

On the DAVID BROWN stand (D.343/238) a representative selection of gear-cutting tools of all types, together with gear measuring instruments, made by THE DAVID BROWN TOOL COMPANY will be exhibited along with patent floating reamers, with micrometer adjustment, and typical jigs and fixtures.

ANGLARDIA, LTD., an associate company of SIR JAMES FARMER NORTON & CO., LTD., will be exhibiting on Stand D.167 lathe tools of standard and special shapes, tungsten carbide tipped drills, reamers, end mills and milling cutters, and metal bonded diamond impregnated tools for grinding tungsten carbide.

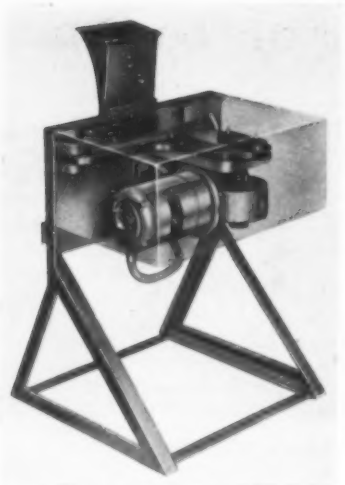
The complete range of the products of WOLF ELECTRIC TOOLS, LTD. will be displayed on Stand C.603, comprising a varied selection of portable electric drills, screwdrivers, grinders, polishers, sanders, blowers, soldering irons and the 10-in. portable electric saw.

Among a varied display on Stand D.402, DELORO STELLITE, LTD. will be exhibiting a complete range of tipped and solid tools, milling blades, centres, workrests and cutters. Several examples of special tools and unusual tooling applications have been collected particularly for the shop man. There will also be a complete range of tangential tools on show.

Other firms concerned with tool steels and small tools include DARWINS, LTD. (D.134); THOS. CHATWIN & CO., LTD. and JOHN BROOKS (LYE), LTD. on the BROCKHOUSE stand (D.405/304); and GEORGE H. ALEXANDER MACHINERY, LTD. (D.632).

Mechanical Testing Equipment

A range of testing machines will be exhibited by SAML. DENISON & SON, LTD. on Stand D.228. It will include a 50-ton self-indicating universal testing machine, a 5-ton self-indicating tensile testing machine, a miniature creep-testing machine, and a compression testing



Courtesy of Rockwell Machine Tool Co., Ltd.

Courtesy of Cabul Tool Co., Ltd.

Penetrascope with standard clamp.

Left—Type SC2 scrap cutter.

Right—BTH electronic Ignitron panel for controlling three-phase power to resistance welding machine

Courtesy of The British Thomson-Houston Co., Ltd.

machine. Of particular interest will be the Model T42U self-indicating universal testing machine of 2,500 lb. capacity. An outstanding feature of the design is the method of load measurement : the true load on the specimen is accurately determined by means of a sensitive knife-edged weighing lever system terminating in a dial indicator which has four capacity ranges representing full, half, fifth and tenth capacity, respectively. Similar machines are available up to 15,000 lb. capacity.

On Stand D.523/420, W. & T. AVERY, LTD. will have on show a universal testing machine fitted with both mechanical and electrical autographic recorders for demonstration purposes. These recorders draw stress-strain curves automatically and accurately—the mechanical one for simplicity and to show the plastic behaviour—the electrical one for high magnification of the elastic behaviour. The latter shows extensions of 40 millionths of an inch.

An exhibit of considerable interest will be found on Stand C.319, where CABUL TOOL CO., LTD. will be featuring the Penetrascope portable hardness tester. In this instrument a 136° diamond pyramid indenter is loaded by means of a hydraulic thrust unit. No outside power is needed, as the unit is operated by finger control, the load being instantly variable by the turn of the handwheel, involving no changing of weights, etc. The indentation is measured by means of an illuminated microscope and a micrometer counter. There are a large number of clamps of different designs available for use with the Penetrascope, suitable for testing metal of various shapes and sizes. The instrument itself weighs 11 lb., the weight complete with carrying case and heavy duty battery being about twice that figure.

The hardness testing machines to be seen on Stand D.632 (GEORGE H. ALEXANDER MACHINERY, LTD.) will include a portable Brinell tester and a Rockwell hardness tester incorporating the latest designs for simple and convenient operation.

Electrical Equipment

The range of products made by the large electrical engineering concerns is so extensive that it is impossible for them to do more than pinpoint selected aspects of their activities. The display of METROPOLITAN-VICKERS ELECTRICAL CO., LTD., on Stand C.510, will include a 3½-ton rotor for the high-pressure cylinder of a 3,000 r.p.m. three-cylinder 60-MW turbine ; an oil circuit-breaker rated at 66 kV, 800 amp., 1,000 MVA ; a 50-h.p. 500 r.p.m. totally enclosed D.C. motor designed to conform with the A.I.S.E.600 series ; an electronically controlled reel drive using dancing rollers ; a model of the 3,000-h.p. gas turbo-electric locomotive which is now on trials with British Railways, Western Region ; and a range of instruments in the standard velometer range. In addition, a display panel will feature the Company's apprenticeship schemes.

The ENGLISH ELECTRIC stand (C.613/512), will also house a number of exhibits dealing with particular groups of products. There will be a typical Diesel power-house layout, comprising a 4RK Mark II Diesel engine with alternator and exciter, together with Type O.B.2 switchgear and combination fuse switchboard ; a comprehensive range of English Electric fusegear ; unitised switchgear cubicles which are designed to form a bolted construction and represent a complete breakaway from the traditional welded construction ; and rectifiers, including a 50 kW 550 V mining type unit. Reference has already been made in the furnace section to the 25 kW induction heater which, together with a range of industrial motors and domestic equipment, completes the display.

Stand C.503/402 will tell the story of the Research Laboratories of the GENERAL ELECTRIC CO., LTD., the tools they use, the results they achieve, and their function within the Company's large manufacturing organisation. For this purpose, the stand will be divided into two parts. The first will contain four working exhibits representative of the tools of research : a spherical integrating photometer ; a turbine vibration test set ; a vacuum pump system ; and a valve vibration life-testing machine. The products of research form the theme of the second part, and will be represented by : cold-pressure welding ; turbine supervisory equipment ; microwave circuits ; and diamond wire-drawing dies.

The central feature of the BRITISH THOMSON-HOUSTON stand (C.511/410), will be a correctly scaled reproduction, over 16 ft. high and 14 ft. in diameter, of a 62,400-kVA vertical water wheel alternator. This unique exhibit will form an appropriate background for a

display of BTH electrical equipment for industry. The exhibits selected to illustrate this theme will cover such aspects as industrial rail transport, machinery drives, machinery control, processes, materials heating, power distribution, lighting and research. Items of particularly metallurgical interest will include steelworks diesel-electric locomotives (photographs), induction heating of tool steel, control panels for resistance welders, and heaters for molten metal baths.

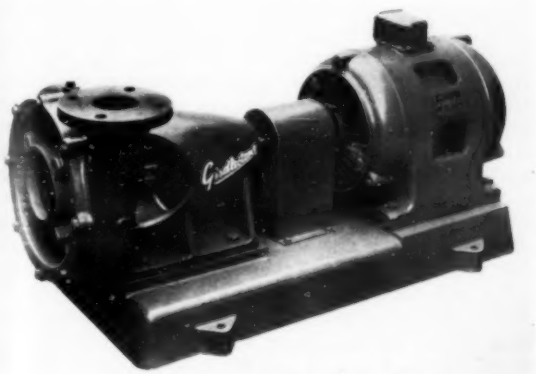
Among the many items of interest, FERRANTI, LTD. (C.615/514) will be showing for the first time: transformers built to the new British Electricity T1 specification: a new polyphase meter test set; a new kVAh meter; a clip-on volt-ammeter which has, until recently, been sold exclusively in the export market but is now available to the home market; and NOduMAG spheroidal graphite austenitic cast iron which has been referred to earlier under Ferrous Castings.

On Stand C.513, BRITISH INSULATED CALLENDER'S CABLES, LTD. will be exhibiting a display of cables and accessories, grouped under the following headings: power station; transmission and distribution; industries and mines; farm and domestic; and transport, including ship, automobile, railway and aircraft.

Oils

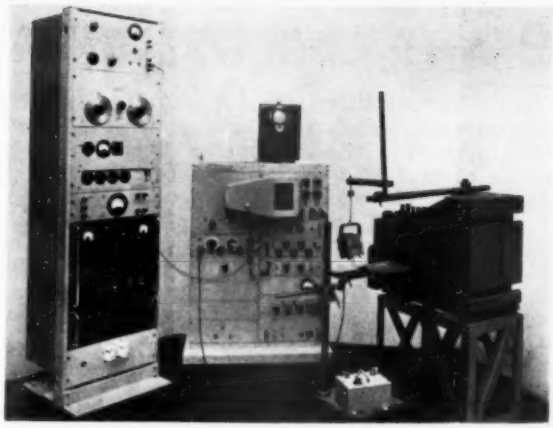
The well-known range of FLETCHER MILLER straight and soluble cutting fluids will be the chief centre of interest on Stand D.510. Attention will also be drawn to metal pretreatment as represented by degreasing compounds, rust and scale removers, rust preventatives and de-watering fluids for the protection of wet ferrous parts. The Fletcher Miller products for the heat-treatment shop will include various grades of carburising compounds and quenching and tempering oils, whilst the press shop will be catered for by an excellent drawing compound made in two grades to cover many types of press working. Technical staff will be in attendance to answer queries relating to industrial lubricants and auxiliaries.

A number of lubricants for the cold working of metals will be featured on Stand D.534 (GULF OIL (GREAT BRITAIN), LTD.). Emulsil CH, a water soluble compound, is suitable for use in drawing large diameter copper tubes, whilst by using Drawing Oil 140 it is possible to produce fine molybdenum wire, by drawing at room temperature through diamond dies, with outstanding die life. Tube Drawing Oil A enables the aluminium fabricators to draw heavy tubes satisfactorily and Deep Drawing Oil 4292 finds application in the production of car bodies. Other products displayed will include a large range of industrial lubricants, cutting oils, anti-rust oils and insulating media.



Courtesy of Girdlestone Pumps, Ltd.

NRF series pump.



Courtesy of The General Electric Co., Ltd.

Apparatus for measuring turbine blade frequencies.

There is no need to stress the importance to the mill manager of producing clean billets in an efficient and economical manner. On Stand C.221, THE W. BLACKWELL OIL CO. will be showing a range of ready-for-use Graphlin mould dressings, suitable for a wide range of non-ferrous alloys, together with oils and greases for a variety of industrial applications.

The stand of ESSO PETROLEUM CO., LTD. (D.433/332) will be laid out for the reception of visitors wishing to discuss the uses of petroleum products with the company's technical representatives. An interesting exhibit, built into the stand, will be a mechanical flow chart of the refining stages of petroleum from crude oil to finished product. By push-button operation, it will be possible to follow a particular product flow from beginning to end.

The VACUUM OIL COMPANY'S new refinery at Coryton, Essex, will be featured on Stand D.629, where there will be a demonstration model of the Thermofor catalytic cracking unit which is now under construction. As in previous years, the stand will be a centre at which industrial management may call for the purpose of discussing lubrication with experienced engineers.

At the time of going to press, we have no particulars of the exhibits on Stand D.317/214, where no doubt SHELL-MEX & B.P., LTD. will be featuring fuel oils and lubricants for all industrial purposes. Cutting oils and quenching oils will also be featured by STERNOL, LTD., on Stand D.751, and on Stand D.142 ALEXANDER DUCKHAM & CO., LTD. will be showing lubricating oils and greases for all industrial purposes.

Miscellaneous

At the 1951 B.I.F., BIRLEC, LTD., concentrated attention on their range of Lectrodryer equipment for the dehydration of air, other process gases and certain organic liquids. The interest aroused was so great that this policy will be continued in 1952, three examples of Lectrodryer equipment being on show on Stand D.509. Two of these will be of the dual adsorber type, with one bed drying whilst the other is being re-activated, whilst

the third, a model CHE dryer, is one of a range designed for controlling humidity in enclosed spaces. Besides these major units, a number of Lab-Lectrodryers will be shown.

On the NEWTON VICTOR stand (C.709) interest will be centred on practical working demonstrations of fluoroscopic examination with the Raymax 140 unit, which is capable of producing first-class radiographs of steel section up to 1¼ in. thickness. It is particularly suitable for radiography of castings and fabrications in light alloys, of thin sheets, rods and tubes of denser materials, and of a wide variety of synthetic materials. In addition to the fixed type of Raymax 140 unit, a completely self-contained mobile model will be shown for the first time, in which the X-ray generator tube unit and control are mounted on a convenient rubber-tyred trolley.

Besides the control instruments referred to earlier in this preview, KELVIN & HUGHES, LTD. (D.626) will have on show for the first time a miniature supersonic flaw detector, which is a lightweight portable non-destructive testing instrument, specifically designed to meet the applications of weld testing and thickness measurement where small-size and portability are essential factors.

The main exhibit displayed by G.W.B. ELECTRIC FURNACES, LTD., on Stand C.321, will be a complete thermal storage plant, including storage tanks, a 200 kW Autolec water heater, auxiliary pumps, control valves and control panel, such as can be installed for heating offices, industrial premises, etc. In addition, 30 kW, 70 kW, and 150 kW Autolec steam raisers and a 100 kW hand-operated water heater will also be exhibited. The steam raisers are self contained, fully automatic units, which can be placed in virtually any position adjacent to the equipment actually using the steam.

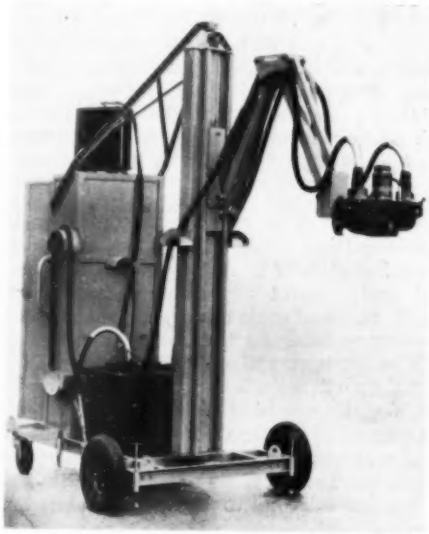
On Stand D.402, DELORO STELLITE, LTD., will have a complete hardfacing bench in operation, similar to the many they have in daily use in their own plant. Demonstrations of the Stellite hard drill will also be given daily, and anyone interested can have samples hardfaced with Stellite or holes drilled in hardened components. The stand itself will show many applications of Stellite in a number of industries, and a wide range of Stellite castings will be shown, including many samples of the precision type.

A special feature on the stand of JOHN RIGBY AND SONS, LTD. (D.607) will be a display of powder metal parts in steel, brass, bronze and nickel silver. Up to 50% saving in raw materials is effected by eliminating machine waste, and precision parts are produced at a fraction of the cost of machining, stamping or forging. Parts suitable for this process can be made to very fine tolerances, and the porosity can be controlled. The last-named feature makes it possible to impregnate the parts with oil.

In the realm of ventilation, HILLS (WEST BROMWICH), LTD., on Stand B.615/512, give a prominent position to their patent roof ventilating shutters. Electrically operated, rust proofed steel louvres, 7 ft. long × 1 ft. 9 in. wide, pivoted at one end and arranged in batteries, are fitted into the roof with a minimum of structural alteration, and induce or expel air in quantities which can be varied by setting the angle of the louvres to different degrees of opening. In this way, use is made of outside natural conditions and interior temperatures and pressures. In conjunction with the roof ventilators, Hills supply controlled wall ventilators.

Air movement of a more localised nature will be featured on Stand D.755/654 by KEITH BLACKMAN, LTD., who will be exhibiting "Tornado" fan equipment for a variety of purposes such as ventilation, dust extraction, boosting gas and air pressures, cupola blowing, and space heating. There will also be a display of oil film and dry type filters, valves and other auxiliary equipment.

A new range of centrifugal pumps, the NRF series, made in sizes from 1½ in to 5 in., will augment the NR series (¾ in. to 1½ in.) on the stand of GIRDLESTONE PUMPS, LTD. (D.434). Other Girdlestone products on show will include hot water system circulating pumps; motor pumps in sizes from ¾ in. to 5 in. and fitted with totally enclosed or drip-proof motors; vertical spindle pumps with floatswitch automatic control; diaphragm pumps for abrasive and corrosive liquids; and rotary pumps for handling non-abrasive viscous liquids.



Courtesy of Newton Victor, Ltd.

Self-contained trolley mounted Raymax 140 industrial X-ray equipment.

The first and only British fork lift truck to incorporate an automatic turbo-drive, thus eliminating the clutch and conventional gearbox and lever will be among the exhibits of CONVEYANCER FORK TRUCKS, LTD. This Company will be exhibiting on Stand D.616/717 as part of the OWEN ORGANISATION and on its own demonstration stand, Outdoor 1358. Several battery electric and internal combustion engine driven fork trucks will be shown, together with a wide range of materials handling attachments with the aid of which a wider variety of loads can be tackled. In the projection theatre on the outdoor site a sound film "Fork Lightening" will be shown, dealing with the manufacture and applications of these trucks.

The industrial uses of magnetic devices is increasing rapidly for such purposes as lifting steel plates, bars, scrap, etc.; sand cleaning by separating tramp iron; concentrating magnetic materials such as ore; holding steel and iron components for grinding and machining; transmission clutches, etc. Each year sees fresh develop-

Continued on page 202

Gold, Silver and Jewellery Industries

Report on Research Progress 1950-51

EVEN industries based essentially on traditional craftsmanship realise the necessity for progress, and when, on the cessation of hostilities in 1945, it was recognised that greatly increased competition would have to be faced in all world markets, the idea of a joint Design and Research Centre for the Gold, Silver and Jewellery Industries was discussed at a series of trade meetings held at Goldsmiths' Hall. These meetings laid the foundation for the setting up of such a centre, where Art and Science could work side by side for the common benefit. Since its inauguration in 1946, considerable expansion has taken place and, in 1950, new premises were occupied at Goldsmiths' Hall.

The Annual Report for the Year 1950–51 gives an outline of the metallurgical work in progress, and it is interesting to note the variety of problems involved, ranging as they do from vacuum evaporation for costume jewellery to the properties of sterling silver and the hardening of pewter. As will be seen from the following notes culled from the Report, the problems under investigation bear a striking resemblance to those arising in other industries even though they are viewed from a somewhat different angle.

Mechanical Polishing.—Although surface finish is of considerable importance in both jewellery and tableware, so too are the production costs involved, and the possibility of mechanising certain operations has been considered. Half a gross of teaspoons have been mechanically polished in America on a machine specially designed for the purpose, and the spoons so polished have been critically compared with the unpolished blanks and with similar blanks hand-polished in this country. The general conclusion has been reached that, apart from edge-smoothing the machine polishing is satisfactory for, but only for, the cheaper grades of flatware.

Properties of Sterling Silver.—The sterling silver alloy containing aluminium (for which patent protection has been obtained for prevention of the defect of " firestain ") has also been found to possess important precipitation hardening properties. The precipitation hardening properties of the standard sterling silver (silver-copper alloy) have not been industrially utilised because the prolonged high-temperature solution treatment often leads to oxide penetration (firestain), and because the hardness achieved (150 V.P.N.) is low compared with the 180 V.P.N. achieved by the maximum cold work. The addition of aluminium overcomes both these difficulties and a hardness of 220 V.P.N. is attainable by heat treatment. Stronger articles can, therefore, be made with the same weight of precious metals, or articles of normal strength can be made lighter.

Substitute Metals.—The metal shortage and orders prohibiting the manufacture of many articles have severely affected the electroplate and fancy jewellery industries and many substitute materials have been suggested by the Centre. Aluminium alloys with plated or anodised finishes offer interesting possibilities and some experimental articles have been made up in 1¼% magnesium super-purity grade aluminium alloy for demonstration purposes. The Centre has also pointed out the potentialities of alloys based on high purity electrolytic manganese. In pursuance of this suggestion, a quantity of 65/35 manganese-copper alloy has been made and its properties examined as a possible substitute for nickel silver. The alloy is strong, ductile and readily temper-hardened but is rather easily corroded; it is not readily electroplated by conventional methods, but trials have revealed possible alternative methods.

Vacuum Evaporation for Costume Jewellery.—The production of a lustrous finish by conventional metal polishing or electroplating processes is expensive, especially in labour. Furthermore, owing to the metal shortages, many articles are now being made of unattractive metals or of plastics. High lustre or polish can be effectively attained on costume jewellery by first lacquering and stoving the articles and then metallising them by vacuum evaporation methods. The lacquer is drawn up by surface tension to a glossy surface which is reproduced by the subsequent thin metallic coating. The metal layer is thin (about six-millionths of an inch) and is usually protected by a top coat of lacquer, which must not, therefore, react (through the pores of the metal) with the first coat. Aluminium especially lends itself to evaporation as the coating is silvery and relatively untarnishable. Although gold can be evaporated, the resulting shade is not always acceptable, and evaporation of a base metal alloy to match a given colour, e.g., to simulate gilding, is as yet difficult, although promising experiments are in hand.

Investment Casting.—Continued attention has been paid to this important method of producing fine jewellery. No entirely satisfactory substitute to replace the cristobalite variety of silica in the plaster-of-paris/silica type of investment has been found, but an entirely different type of investment suitable for all temperatures up to the melting point of silica is being studied. Addition of a small amount of wetting agent has been found efficacious in eliminating air bubbles from the investment slurry, and an improved apparatus has been designed for the injection of the wax into the flexible rubber mould.

Hardened Pewter.—Slightly modified pewter alloys, devised by the Tin Research Institute, enable considerable hardening and in improved " ring " to be obtained by heat treatment. The Centre is helping in the industrial trial of this alloy in the manufacture of hotel hollow-ware and trials are in hand to determine whether such ware distorts and bulges due to repeated heating and cooling, as is the case when it is made of normal pewter.

Miscellaneous.—Other subjects on which research has been carried out include: the cause and prevention of blowholes, porosity and other defects in silversmiths' small sand castings in silver and nickel silver; the prevention of tarnish of sterling silver and electroplate by storage or wrapping in chemically impregnated paper or cloth; and chemical methods of tarnish removal which would be suitable for domestic use.

The Institute of Metals

Annual General Meeting in London

THE 1952 Annual General Meeting of the Institute of Metals was held in London from Monday to Thursday, March 24th–27th. The business meeting and the scientific and technical discussions were held at the Park Lane Hotel, as were a luncheon and dinner-dance, whilst an informal conversazione and exhibition was held on the Wednesday evening at the offices of the Institute, at 4, Grosvenor Gardens.

In accordance with a decision to incorporate the "May" Lecture in the Annual General Meeting, the forty-second of the series was given on the Monday evening in the lecture theatre of the Royal Institution by Dr. J. J. P. Staudinger, who took as his subject "The Place of Plastics in the Order of Matter."

Business Meeting

The official business of the Annual General Meeting was dealt with at a meeting on Tuesday morning, which was opened by the Retiring President, Professor A. J. Murphy, extending to members and visitors, particularly those from overseas, a welcome to the Meeting.

The Report of Council for the Year Ended December 31st, 1951, and the Report of the Honorary Treasurer and Accounts for the Financial Year ended June 30th, 1951, were then adopted. In presenting his report, the Honorary Treasurer, Mr. W. A. C. Newman, referred to the increased cost of printing and paper, which had had a serious effect on the finances of the Institute, whose main function was the publication and discussion of scientific and technical papers. Mr. Newman pointed out that the generous response to the appeal to industry for financial help, much of it in the form of a seven-year covenant, had allowed the Institute a breathing space, which should be used to effect whatever economies were possible.

Officers for 1952-53.—The Secretary then announced the names of members elected to fill vacancies in the Council for the year 1952–53 as follows :—

President: Dr. C. J. Smithells, M.C. (Director of Research, The British Aluminium Co., Ltd.

Vice-Presidents: Mr. G. L. Bailey, C.B.E., M.Sc. (Director, British Non-Ferrous Metals Research Association); Dr. S. F. Dorey, C.B.E., Wh. Ex., F.R.S. (Chief Engineer Surveyor, Lloyd's Register of Shipping).

Honorary Treasurer: Mr. E. H. Jones (Director and General Manager (Bristol), Capper Pass and Son, Ltd.).

Ordinary Members of Council: Mr. Alfred Baer, B.A. (Vice-Chairman, The Consolidated Zinc Corporation, Ltd.); Mr. N. I. Bond-Williams, B.Sc. (Chairman and Managing Director, Aston Chain and Hook Co., Ltd.); Dr. N. P. Inglis, M.Eng. (Research Director, Metals Division, Imperial Chemical Industries, Ltd.); Dr. Ivor Jenkins, (Chief Metallurgist, Research Laboratories, The General Electric Co., Ltd.); Dr. A. G. Ramsay, B.Sc. (Director, The Mond Nickel Co., Ltd., and Works Manager of the Refinery, Clydach, Glam.); Dr. H. Sutton (Director of Research and Development, Aircraft Materials, Ministry of Supply); Major P. Litherland Teed, A.R.S.M. (Deputy Chief of Aeronautical Research and Development, Vickers-Armstrongs, Ltd.); Mr. W. J. Thomas, (Assistant Managing Director, The British Aluminium Co., Ltd.).

As previously announced, Professor F. C. Thompson, D.Met., M.Sc., is to be Senior Vice-President for 1952–53 and he will be the Council's next nomination for the Presidency of the Institution.

Award of Medals.—The Secretary announced that the Council had made awards of medals as follows :—

(i) *The Institute of Metals* (*Platinum*) *Medal* for 1952 to Mr. William Sydney Robinson, until recently President of the Consolidated Zinc Corporation, Ltd., in recognition of his outstanding services to the non-ferrous metal industries in developing the Australian zinc-lead industry and the British zinc industry.

(ii) *The W.H.A. Robertson Medal* for 1951 to Mr. C. E. Davies, for his paper on "The Cold-Rolling of Non-Ferrous Metals in Sheet and Strip Form," published in the *Journal of the Institute of Metals* 1951, vol. 78, pp. 501–536.

(iii) *The Rosenhain Medal* for 1952 to Professor Andre Guinier, Professor of Physics at the Sorbonne, in recognition of his outstanding contributions in the field of physical metallurgy, particularly in connection with precipitation phenomena.

Presidential Address

After expressing his appreciation of the great honour conferred upon him by his election as President, Dr. Smithells said he thought it might be of interest if he tried to give a picture of the changes which had taken place during the life of the Institute. In those 44 years, it had had 24 Presidents and 22 Presidential Addresses, and the latter presented an extraordinarily clear picture not only of the progress of the Institute but also of the development of the science of metals and the non-ferrous metals industry during the past 40 or 50 years, and left no doubt as to the important part that the Institute of Metals had played in those developments. In his "Cavalcade" of the Institute, Dr. Smithells presented different facets of the Institutes' activities, illustrating many of his points by quotations from earlier Presidential Addresses.

Membership.—The Institute held its first meeting in Birmingham in 1908, and by the end of that year had 355 members. It was not until 1918, however, that the thousand mark was reached, and in his Presidential Address of that year, Sir Harold Carpenter gave it as his considered opinion that it should be possible, in due time, to reach and maintain a membership of 1,500. That figure was reached in 5 years, 2,000 in 1928, 3,000 in 1947 and 3,852 to-day. The comparatively slow growth in the early years was due to the very much smaller size of the non-ferrous metals industry, and to the smaller number of metallurgists in the industry, coupled with the character of the industry itself. The production of non-ferrous metals was, at that time, mainly an art, science playing little part, and there was,

in consequence, a degree of secrecy which to-day seems quite incredible. The same kind of secrecy had originally existed in the iron and steel industry, but had by that time largely disappeared, mainly due to the existence of the Iron and Steel Institute, and it was confidently hoped that the Institute of Metals would do the same for the non-ferrous industry. It was many years, however, before the non-ferrous metals industry followed suit, and the earlier insistence on secrecy on the part of manufacturers, and their refusal to take an active part in the meetings of the Institute, led to a vicious circle and provided them with the excuse that there were not enough practical papers. The need for such papers was emphasised in many Presidential Addresses and in 1928 even Dr. Rosenhain appealed for more practical papers, though he tempered his appeal with the very wise comment that the world-wide reputation of the Institute rested on its essentially scientific work.

Meetings.—The problem of satisfying all classes of members had been considered by the Council on many occasions, but it was hoped the changes in the character of the General Meetings of the Institute would show that the problem had been largely solved. From its inception, it was the custom of the Institute to hold two General Meetings each year, in the spring and autumn. The Annual General Meeting in the spring was devoted almost entirely to business and to the presentation and discussion of papers, whereas the autumn meeting also included visits to works, afforded greater opportunities for social contacts, and was often held abroad. For the first 15 or 20 years this arrangement appeared to have been satisfactory and most of those who attended were genuinely interested in a good proportion of the papers presented, the chief reason being that the fundamental principles of scientific metallurgy, which were then being established, were of general interest both to the manufacturer and to the research worker, no matter in what particular metal their main interest was centred. In course of time, however, papers became more specialised and of less general interest, and there was a good deal of criticism and poor attendance when such papers were presented. Dr. Smithells added that he was glad to say that those difficulties seemed to have been surmounted, and a great improvement had been noticeable in recent discussions.

Although Dr. Harold Moore, in his Address in 1934, suggested that discussions or symposia on subjects appealing to selected groups of members should be organised, it was not until 1947 that this suggestion was really put into effect. The first symposium, "Internal Stresses in Metals and Alloys," was held in October of that year and was a real success. It was followed by a series of symposia on subjects of interest to the industrial metallurgist, and it had been decided that in the future at Annual General Meetings one whole day should be devoted to a symposium on a subject of interest to production metallurgists and metallurgical engineers.

In the past, the Council had been reluctant to agree to the formation of separate groups or divisions within the Institute, but the past few years had seen the establishment of a Metal Physics Committee and a Metallurgical Engineering Committee, both of which had been responsible for the organisation of successful symposia. More recently, concurrent sessions on widely different subjects had been arranged to meet the needs of both the practical man and the specialist.

For the future, it had been decided that one in every three autumn meetings should be held outside the British Isles, one should be held in the provinces and one in London, when a foreign metallurgical society would be invited to hold its meeting side by side with that of the Institute.

Publications.—Until 1931, the *Journal* appeared every six months, in bound form only, with the *Abstracts* in a section at the end of the volume. This practice had certain disadvantages in that abstracts appeared much too infrequently, and indeed at such intervals that some of their value was lost. In 1931, the *Journal* and *Abstracts* began to appear monthly. This had the further advantage that members received papers continuously throughout the year instead of in two large batches. There had, not unnaturally, been some criticism of the duplication in abstracting which resulted from the publication of their own separate abstracts by each of the three British metallurgical institutes; the Iron and Steel Institute, the Institute of Metals and the Institution of Mining and Metallurgy. There was not, perhaps, so much duplication as some people might suppose, but quite recently a meeting of representatives of the three institutes was held to consider whether agreement could be reached to publish one comprehensive British abstracts periodical in place of the present three series. Unfortunately, agreement could not be reached, but the prestige which would result from such a British publication was something that should be kept in mind in the hope that eventually a solution might be found.

For many years it had been the Council's policy that the Institute should publish all original papers submitted to it which reached the required high standard, but the volume of matter suitable for publication was constantly growing and the Publications Committee had appointed a Sub-Committee to consider and report what economies in production were possible without seriously affecting the value or readability of the *Journal*. Many Presidents had in the past appealed to authors to express themselves in fewer words, and Professor Thomas Turner, in his Address in 1924, reminded members that the ability to express important facts in simple language was an indication of experience and of clearness of thought, and that in many cases the permanent value of a communication varied inversely as the square of its length!

Other Activities—After dealing briefly with a number of other activities of the Institute, such as the local sections, the sponsoring of research, the fostering of the practical application of scientific knowledge to industrial processes, and, more recently, the consideration of metal reserves and their conservation, Dr. Smithells went on to refer to the important part played by the Institute, in conjunction with similar bodies, in furthering the cause of metallurgical education.

In conclusion, the President said that it was difficult, in a short time, to give an adequate picture of all the Institute had done, or to show to what a great extent the progress of the industry had been made possible by its existence. Nearly all the ideals of the founders had been realised, and in many directions the Institute had progressed further than could have been hoped. It was, however, still young and vigorous, and Dr. Smithells felt sure that there were many directions in which development could still take place, and so increase the service the Institute could render to the science of non-ferrous metallurgy.

Technical Sessions

Technical sessions for the presentation and discussion of papers were held on Tuesday afternoon, Wednesday morning and afternoon, and Thursday morning. Two concurrent technical sessions were held on the Wednesday, one of which took the form of an all-day symposium on "Equipment for the Thermal Treatment of Non-Ferrous Metals and Alloys." The papers presented at the various sessions are listed below.

Tuesday Afternoon

(1) Jointly: ELLWOOD and WEDDLE: "The Production and Properties of Oxide-Reduced Copper Powder" (Jan., 1952)*; BUTLER and HOAR: "Unrelated Simultaneous Interdiffusion and Sintering in Copper-Nickel Compacts" (Jan., 1952); and HOWAT, CRAIK and CRANSTON: "The Sintering of Copper-Zinc Powder Compacts" (March, 1952).

(2) BENSON, MCKEOWN and MENDS: "The Creep and Softening Properties of Copper for Alternator Rotor Windings" (Nov., 1951).

Wednesday—Programme A (Symposium)

(1) EVANS, HANCOCK, HAYWOOD, and MCMULLEN: "Electric Furnaces for the Thermal Treatment of Non-Ferrous Metals and Alloys." (Feb., 1952).

(2) WAIGHT: "Gas Equipment for the Thermal Treatment of Non-Ferrous Metals and Alloys." (Feb., 1952).

(3) DAVIS and TEMPLE: "Batch and Continuous Annealing of Copper and Copper Alloys." (Feb., 1952).

(4) HARTLEY and BRADBURY: "Bright Annealing of Nickel and Its Alloys." (Feb., 1952).

(5) PATON: "Batch Thermal Treatment of Light Alloys." (Feb., 1952).

(6) STAPLES: "Flash Annealing of Light Alloys." (Feb., 1952).

(7) LAMOURDEDIEU: "Continuous Heat-Treatment of Aluminium Alloys of the Duralumin Type." (Feb., 1952).

Wednesday Morning—Programme B

(1) TABOR: "The Hardness and Strength of Metals." (March, 1951).

(2) Jointly: MCQUILLAN (A. D.): "Some Observations on the α-β Transformation in Titanium" (Nov., 1950); MCQUILLAN (A. D.): "The Application of Hydrogen Equilibrium Pressure Measurements to the Investigation of Titanium Alloy Systems" (April, 1951); WORNER: "The Constitution of Titanium-Rich Alloys of Iron and Titanium" (May, 1951); MCQUILLAN (A. D.): "The Titanium-Hydrogen System for Magnesium-Reduced Titanium" (July, 1951); MCQUILLAN (M. K.): "A Provisional Constitutional Diagram of the Chromium-Titanium System" (July, 1951); KARLSSON: "An X-Ray Study of the Phases in the Copper-Titanium System" (July, 1951); JENKINS and WORNER: "The Structure and Some Properties of Titanium-Oxygen Alloys Containing 0–5 At.-% Oxygen" (Dec., 1951); WORNER" "Heat-Treatment of Titanium-Rich Titanium-Iron Alloys: (Jan., 1952); and MCQUILLAN (A. D.): "The Effect of the Elements of the First Long Period on the $\alpha \rightleftarrows \beta$ Transformation in Titanium" (March, 1952).

Wednesday Afternoon—Programme B

(1) Jointly: PERRYMAN and BROOK: "Mechanism of Precipitation in Aluminium-Magnesium Alloys" (March, 1951); SWAIN: "Experiments on the Reaction of Aluminium-Magnesium Alloys with Steam" (Nov., 1951); and EDELEANU: "A Mechanism of Stress-Corrosion in Aluminium-Magnesium Alloys" (Dec, 1951).

(2) HARDY: "The Ageing Characteristics of Binary Aluminium-Copper Alloys" (July, 1951).

Thursday Morning—Metal Physics Session

(1) *Theme: Fatigue.* Jointly: WOOD and HEAD: "Some New Observations on the Mechanism of Fatigue in Metals" (April, 1951); and FORSYTH: "Some Metallographic Observations on the Fatigue of Metals" (Dec., 1951).

(2) *Theme: Plastic Deformation.* Jointly: CAHN: "Slip and Polygonisation in Aluminium" (May, 1951); HONEYCOMBE: "Inhomogeneities in the Plastic Deformation of Metal Crystals" (Oct., 1951); and BROWN: "Slip Bands and Hardening Processes in Aluminium" (Nov., 1951).

* Date of Publication in the *Journal of the Institute of Metals.*

Works Visits

The programme arranged for the Annual General Meeting was concluded by a series of visits to works and laboratories in the London region. They included an all-day visit to the Ford Motor Co., Ltd., at Dagenham; a morning visit to J. Stone and Co. (Charlton) Ltd., at Charlton; and afternoon visits to the Physics Laboratories of the British Iron and Steel Research Association, at Battersea, the Research Laboratories of the General Electric Co., Ltd., at Wembley, and the Precious Metal Refinery of Mond Nickel Co., Ltd., at Acton.

Cathodic Protection Against Corrosion of Buried Metals

A STANDARD form for describing cathodic protection installations to safeguard underground pipe lines against corrosion in this country has been prepared by the British Iron and Steel Research Association's Sub-Committee on the Corrosion of Buried Metals. It is available from Mr. E. E. White, B.I.S.R.A., 140, Battersea Park Road, London, S.W.11., and is to be returned when completed to the Chemical Research Laboratory of the D.S.I.R., Teddington.

Replacement of corroded underground pipes is estimated to cost this country £50,000,000 per year. Cathodic methods of protection as used, for example, on the £2,000,000 oil pipeline from Finnart to Grangemouth in Scotland, show promise of becoming an economic and effective way of cutting this bill. Application of the method, however, will only be effective if the fullest possible information on the subject is examined, correlated and made available to all interested bodies. The most convenient body to do this is the B.I.S.R.A. Sub-Committee (Chairman, Mr. L. C. Whiskin of the Metropolitan Water Board) which has been entrusted by the Minister of Health with the co-ordination of research on this subject.

The form which can be treated as confidential if desired, is in the form of a questionnaire on the protected pipeline and the site in which it is laid, the details of any cathodic protection and the conditions before and after its installation, with details of corrosion failures, repairs, etc.

It is hoped that the form will be widely used to enable the Sub-Committee to obtain a clear picture of the extent and effectiveness of cathodic protection of buried pipelines in this country.

Secondary Light Metal Prices

THE Federation of Secondary Light Metal Smelters announces that following the increases in the Ministry of Supply's prices for raw materials, its members find it necessary to increase the maximum selling prices of the undermentioned alloys on and from Tuesday, April 15th, 1952, as follows:—

L.M.1.	From	£157	per ton to		£163	per ton
L.M.2.	,,	£175	,,	,,	£181	,,
L.M.4.	,,	£163	,,	,,	£169	,,
L.M.6.	,,	£186	,,	,,	£190	,,

Deoxidising Sticks 85/90

From £143 per ton to £149 per ton

Tackling The Pig Iron Shortage

New Method of Charging Borings into the Cupola

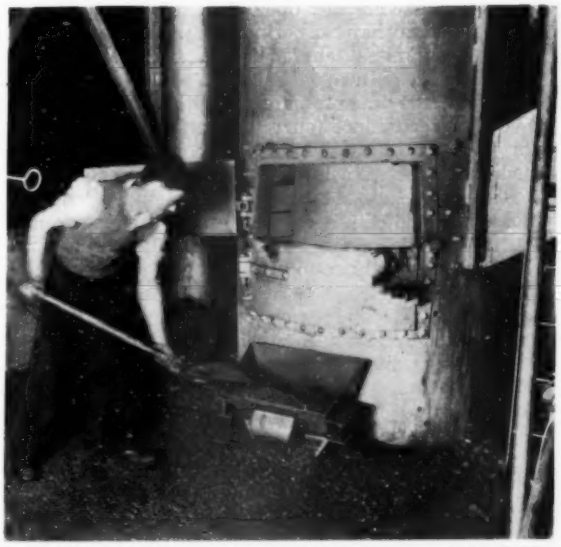
WHEN the steel industry figures for 1951 became available recently, failure to reach the output target was ascribed, in part, to the fact that the iron foundries of the country had increased their output of castings. To this the ironfounders replied that the real cause was the enormous drop in imported scrap and that, in any case, they denied the right of another industry to define, or attempt to define, their rate of expansion. Without going into the question too deeply, it may be accepted that there is little likelihood of scrap imports assuming the proportions they did in 1950 and, in consequence, more pig iron will have to be used for steel production. This state of affairs had, of course, been foreseen and additional blast furnace capacity is coming into operation, but blast furnaces need coke and that is the current bottleneck. Until the coke position improves, therefore, pig iron production is likely to be less than will satisfy demand.

There is, however, one source of supply for the foundries which to date has not received the attention it deserves, and whose importance is emphasized by the present supply position. It has been estimated that the two thousand iron foundries in this country produce each year some 2,000,000 tons of engineering castings which are subsequently machined, and that in some cases as much as 15% by weight of the casting is converted into swarf or borings. Taking an average figure of 10% (which is probably on the low side), there must be some 200,000 tons of cast iron borings produced each year. Figures are not available concerning the disposal of this material, but it is very doubtful whether as many as 10% of the iron foundries in the country take any steps to recover it as metal. Large tonnages are sold for use in roadmaking, etc., at a price which is about half that paid for cast iron scrap.

Charging Borings into the Cupola

The difficulty with trying to introduce borings into the cupola, along with the rest of the charge, lies in the upward blast, which is sufficiently strong to blow the borings out of the top of the cupola. There are at present in use three methods of dealing with this material with a view to its recovery as metal. One of these, remelting in an electric furnace, needs an expensive installation for which maintenance and labour costs are sufficiently high to make it uneconomic for a number of small engineering firms. The other two use the cupola for melting, but in one case the borings are briquetted under pressure, and in the other they are put into canisters. Both methods are of doubtful efficiency as the canisters may burst and the briquettes break up due to the crushing action of the remainder of the charge in the cupola.

In view of the shortage of material and the difficulties associated with existing methods of dealing with borings in the cupola, there will, no doubt, be considerable interest aroused by a patented development recently demonstrated by Crofts (Engineers), Ltd., of Bradford, in which borings are charged into the cupola without any preliminary preparation. In the "Crofts Process," the borings are introduced at a point just above the melting zone where the coke, limestone, pig iron and solid scrap which complete the make-up by the charge is sufficient to obstruct and prevent ejection of the upward blast of the gases from the combustion zone. Furthermore, the borings immediately enter the melting zone, where they are rapidly heated to the melting point and merge with the molten metal and slag produced from the solid charge. In this way, the period when oxidation of the borings and sulphur absorption may take place is reduced to a minimum.



Shovelling cast iron borings into the hopper of the Crofts pneumatic feeder.

The equipment, which costs only about £400, and can be fitted to any cupola in 24 hours, is very simple. Borings are fed by hand or conveyor belt into a hopper situated at or near the charging stage level. This hopper, to which is attached an electro-magnetic vibrator to aid the smooth flow of the borings, surmounts a rectangular section vertical shaft, at the bottom of which is situated the feed chamber. By means of an inclined passage through the brickwork, the feed chamber connects with the inside of the cupola, and the borings are pushed through this passage, which is flared out as it enters the cupola, by a specially designed reciprocating ram operated by compressed air. In this way, the borings are fed into the spaces between the metal and the coke in the region directly above the melting zone.

Features of the Equipment

The equipment possesses a number of interesting features. In the first place, the speed of operation of the ram, which has a stroke of some 9 in., can be varied readily, the input of borings increasing with increase in ram speed. Should the rate of input be increased to a

point where the cupola cannot deal with it sufficiently quickly, there will be a build-up of borings and an increased resistance to the push of the ram. When this resistance rises to an excessively high value, the pneumatically operated ram just stops, without excessive strain on the mechanism such as might arise in the case of a geared electrical drive. When the back pressure falls, the ram continues operating. The equipment may be adjusted to handle borings to the extent of 5–25% of the total metal charged, with 15% representing a normal figure. In a particular case, air is supplied at 80–90 lb./sq. in. pressure and the consumption at 20 cycles per minute (charging some 15 cwt. of borings per hour) is 10 cu. ft./min. The ram is essentially a medium carbon steel rod with two radial projections welded on the top side at intervals along its length, the included angle of the vees so formed varying from one vee to the next. With a material like cast iron borings, there is, naturally, appreciable wear on the ram, but experience suggests that a life of four to six months may be expected. In view of the simple nature of the replacement this would appear to be a reasonable life.

A further point which had to be borne in mind in the design of the equipment is the necessity of preventing noxious fumes from passing through the equipment to the operator on the charging platform. Provided that there is a sufficient height of charge in the vertical shaft, there is no leakage of gas and a safety device is included which prevents the ram operating if the level of borings falls below a predetermined safe position.

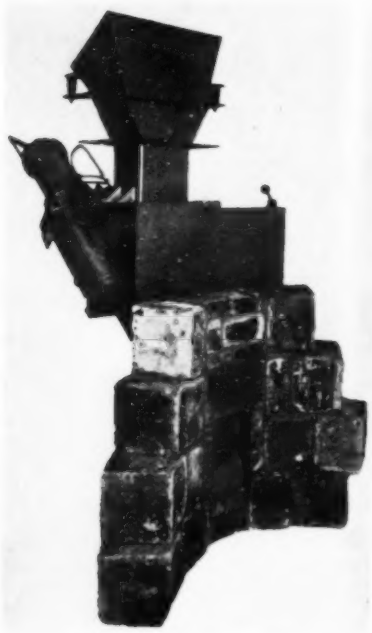
Operating Results

The process has been operating for several months in the Crofts foundries and the results have been very satisfactory. On a 36 in. cupola producing iron for high duty castings with low phosphorus content, accurate determinations were made over a full day's campaign of metal charged and liquid metal delivered. During the first period of the campaign, borings were charged at the rate of 9% of the solid metal charged, and subsequently at a 20% rate, so that the melting losses found—3·3% of the metal charged—represent the average for a 9–20% borings addition range. These losses are no greater than would be expected in normal operation using 100% solid metal charges. Similar losses were obtained from the figures of metal charged and castings produced over a period of three months, the losses amounting to 5%, which may be allocated as 3% loss in melting and 2% in spillage and fettling losses. During this period, the cast iron borings melted represented 26·8% of the total metal used in the foundry.

Results also indicate an increase in the melting rate of cupolas using the Crofts Process for boring reclamation, and casting temperatures are attained with a reduced coke/iron ratio due to improved thermal efficiency.

Economic Aspect

As the melting losses are no greater when charging borings by this process, the borings can be regarded as equivalent to the same weight of solid scrap. It follows, therefore, that return of borings to the cupola instead of their dissipation in non-metallic channels, represents an increase in raw material to the ironfoundries. There is also a financial advantage to be gained. It is estimated that the use of 20% of borings in a two-cupola foundry melting 200 tons of metal per week, would result in a net annual saving approaching £13,000, assuming that the borings would otherwise have been sold at the market price of £3 10s. per ton.



Demonstration unit fixed to mock-up cupola wall.

Graduate Courses at Birmingham University

As part of a national scheme to maintain a supply of men fitted for technical positions of major responsibility in industry, a Graduate Course in Metallurgy has been arranged at Birmingham University. It provides a year's training in industrial metallurgy at post-graduate level for men who hold degrees in metallurgy, physics, chemistry or engineering, and who are already engaged in, or proposing to enter, metallurgical industry.

Lectures and tutorial classes deal with industrial metallurgy; structural metallurgy; principles of refining, melting and casting; principles of working of metals, heat treatment and welding; and modern laboratory techniques. Extensive use is made of the seminar system in which students present papers for discussion on selected topics in industrial metallurgy. Practical work is carried out principally with the full-scale manufacturing plant in the new Aitchison Laboratories. The course includes studies in metallurgical works of problems arising in industrial production. On satisfactory completion of the course students receive the Diploma in Post-Graduate Studies (Metallurgy).

The course begins on 6th October, 1952: further particulars and forms of application may be obtained from the Registrar, The University, Edgbaston, Birmingham, 15. Particulars of two other graduate courses beginning at the same time, one in chemical engineering, and the other in thermo-dynamics and related studies, may also be obtained from the same source.

New and Revised British Standards

Covered Electrodes for the Metal-Arc Welding of Mild Steel. (B.S.639 : 1952)

Price 4s. Post Free

This standard supersedes the previous edition which was issued in 1935. Unlike the 1935 edition the new standard specifies only one class of normal penetration electrode. In line with recent developments, requirements for deep penetration electrodes are included. A comprehensive scheme for testing electrodes is laid down. This involves initial tests to which each type or modified type of electrode is subjected, and periodic check tests which consist of a selection of the initial tests and which are to be repeated at intervals to provide evidence that the electrodes currently produced continue to possess the properties recorded in the initial tests.

For normal penetration electrodes the initial tests are all-weld tensile, all-weld impact, tee joint fillet weld hot cracking, transverse tensile, transverse bend and cruciform fillet weld tensile. The periodic check tests are the all-weld tensile and tee joint fillet weld hot cracking tests. For deep penetration butt welding electrodes the initial and periodic check tests are transverse tensile, transverse bend and butt weld penetration tests. For deep penetration fillet welding electrodes the initial and periodic check tests are cruciform fillet weld tensile and fillet weld penetration tests.

In the foreword it is emphasised that an assessment of the quality of an electrode and its suitability for use on general or particular work cannot be based solely on numerical results obtained from a series of mechanical tests such as those laid down but must take into account various other factors which do not readily admit of precise definition : the factors concerned are enumerated.

Methods for the Use of British Standard Fine-mesh Test Sieves. (B.S.1796 : 1952)

Price 3s. 6d. Post Free

Sieving tests are used in many industries for the routine control of the quality of materials, for research on their properties and for specifications concerning their marketing. Uniformity of procedure for the sieving tests is highly desirable to facilitate comparisons between tests made in different laboratories. B.S.410 'Test sieves' limits the tolerances of sieving cloth for test sieves as closely as manufacturing conditions permit, but there is need for guidance to operators in the method of using the test sieves. The need for such instruction has been realized for some time by those concerned in test sieving operations, and this was confirmed by the replies to a questionnaire issued by the Committee, in which widely differing procedures were quoted.

No single method of sieving analysis can be specified to cover the many different types of material concerned. Some materials are difficult to sieve and require specially developed techniques ; it is, however, possible to formulate general principles of sieving which may be applied to many natural and artificial materials. In framing methods of procedure consideration must also be given to the object of the test, i.e., whether for routine control of manufacture or for a comprehensive programme of research on the properties of the material. Certain industries especially concerned with the sieving analysis of powdered materials have formulated specifications for the sieving procedure and these are incorporated in the appropriate British Standards. The recommended methods given in B.S.1796 are not in any way intended to supersede such specifications, but are to serve as a general guide to sieve users.

This standard gives information on the principles of sieving as well as on the equipment to be used. It then proceeds to define the method by which the sample should be prepared for the test and the weight of sample to be taken. The sections that follow deal with the removal of fine dust by both the dry and wet methods. The actual sieving procedures are sub-divided into those dealing with hand sieving to the 'end point' by the rate test, machine sieving to the 'end point' by the rate test and a routine sieving test. Other sections deal with such subjects as loss of dust during sieving, sieving tests on materials with only a small weight of oversize on the sieve, and the method of reporting results and accuracy of results. Finally, appendices are included dealing with methods of sub-dividing bulk samples which have been abstracted from B.S.735—'Sampling and analysis of coal and coke for performance and efficiency tests on industrial plant' and some additional notes on procedure.

Tables for use in the Calibration of Volumetric Glassware. (B.S.1797 : 1952)

Price 10s. 6d. Post Free

This British Standard has been prepared in response to requests from the National Physical Laboratory and from industry for the publication of tables, in compact and readily accessible form, for use in the calibration of volumetric glassware. Tables used hitherto are no longer easily obtainable and do not relate to present day apparatus, which is standard at 20° C. and not 15° C. as formerly.

The standard contains two sets of tables ; one set relates to vessels made of soda glass and the other set to vessels made of borosilicate glass. Each set is appropriate to the conversion of the observed weight, in grammes, in air of average density, of the distilled water contained or delivered by a glass vessel at a known temperature, into the volume of the vessel at 20° C. In addition, tables are provided for the correction for the departure of the effective air density from the average air density assumed in the tables mentioned above ; the conversion of the weight in air of the mercury contained or delivered by a glass vessel at a known temperature to the volume of the vessel at 20° C. ; and the conversion of the nominal volume of a glass vessel at 20° C. to the weight in air of the mercury contained or delivered by it at various temperatures. The tables allow for the current density of the liquid, the change of volume of the vessel with temperature, and the buoyancy of the air during the weighing. The basic figures from which the working tables have been calculated were prepared by the National Physical Laboratory.

The values used for the coefficient of cubical expansion of glass in the tables for soda glass and borosilicate glass are good average values for the two types of glass used for volumetric glassware manufactured in the United Kingdom. When the expansion of the glass is known to

differ from that used in the tables and the temperature of water is far removed from 20° C., it may be necessary, when working to a high degree of accuracy, to make the appropriate adjustment.

POWER RATING OF VALVE-DRIVEN HIGH FREQUENCY INDUCTION HEATING EQUIPMENT. (B.S.1799 : 1952)
PRICE 2s. 6d. POST FREE

THIS standard specifies the method of expressing the power rating of valve-driven high frequency induction heating equipment operating from single or polyphase mains supplies. The appendices explain the significance of output voltage and current in relation to power ratings and give examples of methods of output power measurement. Until now no uniform practice has been observed in the power rating of high-frequency induction heating equipment, some manufacturers preferring to state the power taken from the supply mains while others give a figure for the output determined under arbitrary conditions. Users of this equipment need information on both input and output power and may, in addition, require some guidance on the voltage and current available at the output terminals. This standard has been prepared, therefore, to enable uniformity of practice to be achieved in the power rating of this type of high frequency heating equipment, and to give guidance and information on the subject.

Copies of these standards may be obtained from the British Standards Institution, Sales Department, 24, Victoria Street, London, S.W.1.

The British Industries Fair

Continued from page 194

ments in this field, and those interested should visit Stands C.421 and C.605 where can be seen the exhibits of RAPID MAGNETIC MACHINES, LTD., and ELECTRO-MAGNETS, LTD., respectively.

The simplicity of design of the straight-through diaphragm valves exhibited by WYNN (PRODUCTS), LTD., on Stand D.747, makes them readily lined with glass, rubber or lead, for use where cast iron, steel or bronze equipment would be unsatisfactory. This factor, combined with the ease of cleaning and the fact that they are self-draining has led to their successful use with a variety of corrosive and abrasive liquids.

Year after year, Factory Inspectors' reports show that of all the occupational diseases continually sapping the strength of the country's labour force, dermatitis easily heads the list. ROZALEX barrier preparations are well known for the protection of the skin against all classes of irritant materials used in industry, and a range of such preparations will be shown on Stand D.706, together with the Rex Dispenser, an appliance designed to provide an economical and uncontaminated supply of Rozalex to the worker whenever required. Preparations for this purpose will also be shown by STERNOL, LTD., on Stand D.751, and by ALEXANDER DUCKHAM & CO., LTD., on Stand D.142, where a colour film dealing with the subject will also be shown.

No details are yet to hand of the display on Stand D149, where FLAME HARDENERS, LTD., makers of equipment for surface hardening of steel, will be exhibiting.

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STEEL PRODUCTION

Search out every ton of scrap in your works and turn it in. Old plant, redundant buildings, machines and spares — it's all wanted back in the steelworks to keep up steel production. Round it up and put it in the hands of your local scrap merchant. It will go to make the new steel that you and every other steel user need so urgently.

Scrap merchants are glad to help with dismantling and collection.

WHEREVER YOUR NEW STEEL *comes from, please return your scrap to merchants in your own locality. That will save unnecessary transport, and time, before the old scrap is turned into the new steel all steel users want.*

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SPEED THE STEEL

Issued for the STEEL SCRAP DRIVE by the British Iron and Steel Federation

STEEL HOUSE, TOTHILL STREET, LONDON, S.W.1

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NEWS AND ANNOUNCEMENTS

The Iron and Steel Institute

Award of Medals and Prizes

THE Council of the Iron and Steel Institute announce that the following medals and prizes will be presented at the Annual General Meeting during the morning session on Wednesday, 30th April, 1952 :—

Bessemer Medal.—To MR. H. H. BURTON, C.B.E. (English Steel Corporation, Ltd.) for his distinguished services to the steel industry and to metallurgy, with particular reference to the development of alloy steels and of heavy forgings.

Sir Robert Hadfield Medal.—To DR. L. REEVE (Appleby-Frodingham Steel Co.) in recognition of his contributions to the science and practice of ferrous metallurgy and, in particular, his researches on the weldability of low-alloy steels.

Williams Prize.—Jointly to MR. J. A. BOND (Appleby-Frodingham Steel Co.) and MR. T. SANDERSON (Workington Iron and Steel Co.) for their paper on "Full Scale Blast-Furnace Trials" (*Journal of the Iron and Steel Institute*, 1951, vol. 168, May, pp. 24–39).

Annual General Meeting

THE 83rd Annual General Meeting of the Iron and Steel Institute will be held on Wednesday and Thursday, 30th April and 1st May, 1952. The opening meeting, at which Capt. H. Leighton Davies, C.B.E., will deliver his Presidential Address, will be held at the Royal Institution and will be followed by the Sixth Hatfield Memorial Lecture. This will be given by Professor E. N. da C. Andrade, D.Sc., Ph.D., F.R.S., on "The Flow of Metals."

At each of the three subsequent technical sessions, to be held at 4, Grosvenor Gardens, London, S.W.1., a group of papers with a common interest will be presented for discussion. That to be held on Wednesday afternoon will have as its theme cold working, with particular reference to cold rolling, whilst the aerodynamic and combustion aspects of open-hearth furnaces, and hydrogen in steel will be discussed at the morning and afternoon sessions on Thursday, 1st May.

A Members' Dinner will be held at Grosvenor House, Park Lane, on Wednesday, 30th April.

Institute of British Foundrymen

Annual Conference

THE Annual Conference of the Institute of British Foundrymen is to be held at Buxton and Sheffield from June 10th to June 13th inclusive. The Conference will be held mainly at Buxton, but on June 13th, the whole of the day will be spent in Sheffield with the exception that members and ladies will return to Buxton in the evening for the concluding event of the Conference, namely the Dinner-Dance. The Conference will open on the evening of June 10th, with a reception by the Mayor and Mayoress of Buxton. There are the usual business meetings and technical sessions and a wide choice of works visits. An innovation is that on June 12th, three simultaneous technical sessions will be held both in the morning and afternoon to enable papers to be more fully discussed than has been possible at past Conferences. Social events will include the Annual Banquet on June 11th and the Dinner-Dance on June 13th, and an attractive programme of social events and excursions has been devised for the ladies. On the morning of June 13th members and ladies will visit the Town Hall, Sheffield, by invitation of the Lord Mayor (Ald. Peter Buchanan, J.P.), when the Civic Plate will be on view. This will be followed by luncheon at the City Hall, Sheffield.

Student's Grant, 1952

FOR the past three years part of the funds that have been made available to the Institute for technical and educational development purposes by the Joint Iron Council has been used to assist promising young men in the foundry industry with their studies, and the Council have decided to offer a further grant to enable a course to be taken at the National Foundry College during the session 1952–53.

Any foundrymen or students who desire to be considered for this award are invited to make a formal application to the Secretary of the Institute, St. John Street Chambers, Deansgate, Manchester, 3. Fullest particulars should be given by each applicant, including name, age, address, present employer, chronological account of previous experience and a chronological account of technical studies. The Council will endeavour to secure the co-operation of the selected candidate's employers to ensure him continuity of employment.

Institute of Metal Finishing

Organic Finishing Group

THE Electrodepositors' Technical Society has recently become an incorporated body under the title of the Institute of Metal Finishing. As such it will extend its activities into the field of organic finishing generally. The emphasis will be on the process side and technology of metal finishing rather than on the chemical side of organic finishing materials. The latter aspect is admirably covered by such bodies as the Oil & Colour Chemists Association and the various paint trade bodies, but from the point of view of those engaged in the practice of metal finishing using organic coatings there has hitherto been no adequate forum for discussion and the dissemination of information.

As is well known, a considerable number of members of the Institute, indeed the majority, are already directly interested in organic finishing as they are concerned with practically all aspects of the finishing of metals and not only with electrodeposition. Many of the technical meetings already held in the past have been devoted either wholly or in part to methods of metal finishing outside the confines of electrodeposition proper.

The Institute will continue its policy of being completely independent and free from commercial attachments. Its fundamental tasks are the publication of technical papers, the arrangements of meetings and conferences, and any other activities that may serve to

spread knowledge and increase the efficiency of industrial practice.

At a preliminary meeting held recently between a number of individuals interested in organic finishing and members of the Council of the I.M.F. it was decided that the best way to implement these objectives would be to form an Organic Finishing Group open to all members of the Institute. To inaugurate this Group a Delegate Committee as representative as possible of the industry will be appointed in the first instance to organise a Conference in the Autumn of 1952. The latter will be partly a technical and partly a business meeting at which the election of the Committee and Officers of the new Group will take place. A further announcement giving details of the Autumn Meeting will be made in due course.

The Institute of Welding

Spring Meeting

THE Institute of Welding is holding its Spring Meeting this year in Glasgow on April 24th, 25th and 26th.

The whole of the 24th will be taken up with two works visits for a limited party, who will inspect the Linwood Factory at Paisley of the Pressed Steel Co., Ltd., in the morning and the Clydebridge, Cambuslang, works of Colvilles, Ltd., in the afternoon.

The presentation and discussion of technical papers will occupy the mornings of April 25th and 26th. Papers to be presented are :—

"The Construction of a High Speed Wind Tunnel," by J. H. BELL, A.M.Inst.W.

"Some Changes in the Shipyard with Particular Reference to Oil Tanker Construction," by J. RANNIE, M.I.E.S., M.I.N.A.

"Welding in Hydro-Electric Plant," by J. CRAWFORD, B.Sc.

"Light Weight Welded Construction in Mechanical Engineering Structures," by F. KOENIGSBERGER, Dipl.Ing., M.I.Mech.E.

On the afternoon of the 25th, there will be a choice of works visits to Sir William Arrol & Co., Ltd., Dalmarnock Iron Works, John Brown & Co., Ltd., Clydebank, and Harland & Wolff, Ltd., Ordnance Works.

Social engagements include a whole day excursion for ladies on the 25th and a Dinner that evening, at which the Lord Provost will be represented. The President of the Institute, Mr. Howard J. Thompson, M.I.Mech.E., will preside over the meetings.

Exhibition of Packaging for Gold, Silver and Jewellery

THE Design and Research Centre for the Gold, Silver and Jewellery Industries proposes to hold an Exhibition illustrating the importance of suitable packaging for gold, silver and jewellery products. The Exhibition will cover as wide a field as possible and will present the results of investigations into protective materials and display presentation. The Exhibition will be held at the Centre, in Goldsmiths' Hall, concurrently with the British Industries Fair.

Change of Address

EUMUCO (ENGLAND) LTD., have moved to larger London Offices at 12, Great Portland Street, London, W.1. (Telephone : Museum 2596–7.)

Personal News

MR. J. H. MAYES, Manager of the Development Division of Northern Aluminium Co., Ltd. since 1946, has been appointed Castings and Forgings Sales Manager. He is succeeded by MR. H. M. LOUCH who joined the Development Division on his appointment to the Company in 1946 and for the last year has been on the staff of the London Sales Office. The Publicity Department, which has hitherto been part of the Development Division, is now a separate Division under MR. E. D. ILIFF, who has been Publicity Manager for the last seven of his seventeen years with the Company.

MR. H. C. BUTCHER, Secretary of the Samuel Fox Branch of The United Steel Companies Limited, retired at the end of March after 52 years with Samuel Fox & Co., Ltd. Mr. Butcher, who was the fourth secretary since the formation of the company in 1871, will be succeeded by MR. F. STONES, A.C.I.S.

ELLIOTT BROTHERS (London) Ltd. announce that MR. J. F. COALES has resigned his position as Research Director of the Company.

MR. E. L. O'FLANAGAN, MR. S. W. PARROTT and MR. F. W. POWELL have been elected to the Board of Hale & Hale (Tipton) Ltd.

MR. FELIX L. LEVY, a Director of George Cohen, Sons & Co., Ltd. and its associated companies, has been elected President of the London and Southern Scrap Iron and Non-Ferrous Metal Merchants Association.

MR. F. SWIFT, Manager of the Steel Foundry of The Darlington Forge, Ltd. for 25 years, has retired after 50 years' service.

THE Council of the Institute of Fuel have awarded the Melchett Medal for 1952 to DR. D. T. A. TOWNEND, in recognition of his outstanding contributions to the science of combustion. Dr. Townend is the Director General of the British Coal Utilisation Research Association.

MR. JOHN BOLTON, Technical Secretary of the Research and Development Division of the British Steel Founders' Association, is acting as Secretary of a Technical Assistance Mission representing European foundry interests, the largest mission which has yet been sponsored by the O.E.E.C.

MR. W. J. DRISCOLL has resigned from the staff of the British Cast Iron Research Association to become General Manager of the newly formed company, Cupodel, Ltd.

Obituary

WE regret to announce the death, on March 30th, 1952, of Sir Andrew Duncan, Independent Chairman of the British Iron and Steel Federations' Executive Committee, a position he had held—with a break during World War II—since 1935. With the outbreak of war, the Federation was merged in the Ministry of Supply as the Iron and Steel Control and in 1940, after a short term as President of the Board of Trade, Sir Andrew became Minister of Supply, retaining that office until the end of the war. Returning to the Federation in 1945, Sir Andrew, who was M.P. for the City of London until 1950, was one of the principal Conservative speakers in the House of Commons on the nationalisation of the iron and steel industry.

CURRENT LITERATURE

Book Reviews

THE MANUFACTURE OF IRON AND STEEL VOL. II.—STEEL PRODUCTION

By G. Reginald Bashforth, F.I.M. Demy 8vo. 461 pp., 219 illus. Published by Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 45s. net.

In presenting this work the author has performed a very useful service, particularly for students who will find suitable textbooks on the subject rather scarce. For convenience the work has been divided into two volumes. Vol. I, which is uniform with the present volume, is concerned with iron production and deals with iron ores and their preparation, the blast furnace burden, reactions in the furnace and slags; it includes discussions on the principles of blast furnace design, and deals with other plant and equipment as well as their operation; blast furnace calculations, electric resistance furnaces, instruments, and wrought iron are also discussed in that volume.

The present volume, which surveys the basic principles of the various steelmaking processes, together with details of the plant and equipment involved, gives in simple language and concise form the results of long experience of steelmaking in many of its processes. A brief summary of the contents indicates the comprehensive manner in which the author deals with the subject of steel production. He begins with an historical note on the Bessemer process and deals with the principles and plant involved. The acid and basic Bessemer processes are described in separate chapters. In each case particular attention is given to the materials used, to the manufacture of the steel by each process and to some of the purposes for which the steel is used. The general principles of the open hearth process are given in a following chapter, in which are discussed reversing valves, layout of plant, charging machines, and disposal of the products. The open hearth furnace is described at some length in another chapter and separate chapters are devoted to detailed consideration of the acid open hearth process and the basic open hearth process. Careful attention is given to open hearth fuels, including producer gas, natural gas, pulverised fuel, mixed-gas firing, oil fuels, and colloidal fuel, and to the principles of heat transfer. Various types of arc furnace are described, as well as low and high frequency furnaces, and the melting practice applied in each type. Special chapters are also devoted to side blown converter practice and to the manufacture of blister, shear, and crucible steel. The author deals very fully with ingots and ingot production, discussing casting-pit practice, layout, slag disposal, ingot moulds and methods of teeming, solidification and structure of various types of ingots, and includes different types of ingot defects. Modifications of steelmaking practice are reviewed in a chapter which deals with mixer practice and the Bertrand-Thiel, Talbot, Monell, Twynam, Perrin, duplex, triplex, and cupola-open-hearth processes. The economics of the various processes are also discussed. In recent years considerable progress has been made in steelworks instrumentation and the author gives special attention to this subject. The last two chapters are concerned with the manufacture of some types of special steels and refractory materials used in the manufacture of steel. Sundry thermal data are included and the book is complete with an adequate index.

The present volume is a valuable contribution to the subject of steel production. Considering the size of the volume the author is to be congratulated on such an admirably balanced presentation of an extensive subject, and on the selection of illustrations he has chosen. As a textbook it should prove extremely helpful to the student of metallurgy, but it should also prove a handy work of reference for the busy industrialist, while many steelmakers will find it informative and useful. B.S.

CHEMICAL AND ELECTROPLATED FINISHES—THE PROTECTIVE TREATMENT OF METALS

By H. Silman. Foreword by Dr. H. Moore. 2nd Edition. 479 pp., 135 illustrations. London, 1952. Chapman and Hall, Ltd. 50s. net.

The first edition of this book appeared four years ago and immediately claimed first place as a manual for the electroplating industry. This resulted not merely from the author's objectives, i.e., to present a reasonably comprehensive account of modern industrial finishing processes, together with the chemical and physical principles involved in them, but probably more from the concise and accurate manner in which he achieved his objectives.

The second edition was prepared with the same objectives, and, to cater for the rapid developments in protection and plating between the two editions, some revision of existing matter and of illustrations has been made, together with substantial additions. This has been achieved with an increase in space of only fifteen per cent., because the same concise style has been maintained, making for easy reading and rapid reference.

The opening chapter, giving a brief account of the principles of corrosion, and the corrosion of metals, provides a useful, factual introduction. The remainder of the book deals with industrial processes, in all cases giving a brief scientific explanation, the processes proper, plant requirements, process control and testing.

A third of the volume is devoted to the preparatory processes of descaling and pickling, polishing, and degreasing and cleaning. In these sections, the new vapour process of abrasive blasting and the sodium hydride method of descaling have been added. Reference is made to the newest constructional materials for severe service in pickling plants. Under polishing, information has been added on barrel and band methods, and on the polishing compositions used; notable additions have been made under electrolytic and chemical polishing. Emulsion cleaning has been given more attention, the use of perchlorethylene included under solvent processes, and the Fraser-Heller type of plant dealt with in full.

In the section on colouring and chemical finishes, blue for steel and black for stainless steel have been added,

whilst the section on phosphating has been re-written with the influence of surface treatment and the roto-dip process as notable additions.

In the section on modern plant, additions include the vinyl linings, the "British" type of plate filter, new information on barrels, return-type automatic plating machines, effluent disposal and rack insulation.

A quarter of the book is given to the electrodeposition of the various metals. Electropolishing of silver coatings; the use of carbon-type nickel anodes and of organic brighteners for bright nickel plating; control by the Hull cell; ortho-phosphate, fluoborate and P.R. copper processes; the fluoborate and a bright zinc electrolyte: precise information has been presented on these subjects.

With respect to the light alloys, more attention has been given to the pre-polishing of aluminium and data cited for the plating of magnesium.

Finally, the useful section on testing methods, has been expanded. Thickness measurement by chemical, jet and drop, and magnetic methods are given special attention.

The task of keeping a treatise on industrial finishing up-to-date is an unenviable one; when it is an authoritative practical volume and new techniques are rapidly being developed, it is one of great magnitude. The author of "Chemical and Electroplated Finishes" has grappled with this problem very successfully. This revised edition is recommended to all concerned with metal finishing, chemists and electroplaters, plant engineers and factory managers, and the information presented can be fully relied upon as up-to-date and accurate.

E.E.H.

Trade Publications

'Triangle' pure oxide ware is the subject of a new leaflet issued by The Morgan Crucible Co., Ltd., and particulars are given of the properties and uses of fused alumina (90–91% Al_2O_3), pure alumina (99% Al_2O_3), and recrystallised alumina (99·7% Al_2O_3). These materials can be used at temperatures up to 1,700° C., 1,800° C and 1,950° C., respectively. Details are given of the standard patterns of crucibles, trays, dishes, boats, tubes, sheaths, and thermocouple insulators made in the recrystallised alumina.

We have received from The Benjamin Electric Ltd. a copy of an interesting little booklet concerned with Benjamin "Crysteel" vitreous enamel which is used on the reflectors of Benjamin illumination units. The progress of enamelling through the ages is outlined before details are given of the manufacture and application of Crysteel.

From Air Control Installations, Ltd., Ruislip, Middlesex come two new publications, Nos. B 515 and B 521, dealing with Multi-Duty Air Filters and Airmat Dust Arresters, respectively. The former are highly efficient self-cleaning filters employing a continuous viscous-coated air curtain. They are distinguished by the interchangeability of the types of panel forming the air curtain, allowing ready adaptation to meet any changed operating conditions. The Airmat Dust Arresters are suitable for handling linty, fibrous and fine-grain process dusts, and the design, employing a unit type frame with removable pocket-like holders, simplifies installation, conserves space, and allows quick and easy replacement of the filter material. The Arresters are available in two types—the Dustbox suitable for individual dust sources or small groups of machines, and the Central System for cleaning large volumes of air.

The current shortage of metals of all types makes economical melting of more than usual importance, and in this respect, indirect arc electric furnaces show many advantages. These are outlined in the revised issue of Birlec Publication No. 65, dealing with the standard range of Birlec–Detroit rocking arc units. The brochure also contains useful application data, including up-to-date running costs of melting both ferrous and non-ferrous metals. Copies may be obtained from the Publicity Dept., Birlec Ltd., Tyburn Rd., Birmingham, 24.

John G. Stein & Co., Ltd., Bonnybridge, Scotland, have just issued a revised version of their Pamphlet No. 1—"Firebricks." Technical data are given for Firebrick Brands, Silica Brick Brands, High Alumina Brands and Basic Bricks, together with information on the correct lighting-up procedure, estimation of brickwork, and service applications for firebricks and high alumina bricks. In the past too many sizes of firebricks have been regarded as "standard" and this has been against efficient manufacture and adequate stocking. A list of sizes now accepted as standard is given together with tables for combinations of sizes for arches and circles.

We have received from W. H. A. Robertson & Co., Ltd., Bedford, an excellently produced illustrated booklet presenting a selection of photographs of rolling mill installations for which the Company has been responsible. Robertson's have been building rolling mills since 1908 and have pioneered many new developments, but in order to limit the booklet to a convenient size, the selection has been limited to a fraction of the plants installed during the last 10 years or so. The text matter appears in English and French.

Aluminium bronze diecastings are now widely used for stressed components in motor cars, railway engines, mining machinery, machine tools, electrical switchgear, steam traps, oil burners, textile machines and hundreds of other applications. Those firms who regularly use such diecastings find little difficulty in machining the alloy, but the best results are always obtained by taking into account the properties of aluminium bronze. In a recently published leaflet "Machining Aluminium Bronze Diecastings," Fry's Diecastings, Ltd. give their own recommendations and those of a large number of users who have been kind enough to pass on the benefit of their experience. Copies may be obtained from Fry's Diecastings, Ltd., Brierley Hill Road, Wordsley, Stourbridge, Worcs.

Readers who need to indicate, record, integrate, transmit and automatically control the flow rates of the liquids and gases they are handling will be interested in Catalogue No. 51 1 B, the latest publication of Solway Flowrators, Ltd., who are manufacturing selected products of the Fischer and Porter organisation (U.S.A.) —at present Flowrator flow meters for pipe lines of up to about 2 in. nominal bore. These are variable-area flowrate meters comprised of a vertically mounted, tapered bore tube, within which the position assumed by a freely moving float determines the instantaneous rate of flow.

METALLURGICAL DIGEST

Low Temperature Service Steels

By John L. Everhart

THE properties of materials at low temperatures have become increasingly important in recent years, because of the expanding use of such temperatures in the chemical processing industries and the need for the operation of military equipment and aircraft under sub-freezing conditions.

In general, the lowest ground temperature reached is about −65° F., although occasional temperatures as low as −90° F. have been reported. In the upper air, at altitudes reached by aircraft, the lowest ambient temperature is about −130° F. Some authorities believe that no part of the plane reaches this temperature, however, because of aerodynamic heating. In the chemical field the range is much greater.

In general, the strength and hardness of steels increase with falling temperatures. The ductility, as measured by the tension test, shows little change or decreases slightly down to temperatures near −250° F., below which there may be a sharp drop. Under shock loading in the presence of a notch, steels act in quite a different fashion. Some retain their toughness to low temperatures, others become embrittled at temperatures only slightly below freezing.

Both metallurgical and mechanical factors are involved in the selection of steels for low temperature service. Among the former melting precedure, chemical composition, the finishing temperature for hot rolling, internal structure, grain size and heat treatment influence the temperature at which the steels become embrittled. Among the latter, design of the part, presence or absence of notches, restraint, type of loading, size and shape influence the manner of failure of the material.

Investigations at low temperatures have shown that the face-centred cubic metals retain their ductility and toughness to the lowest temperatures which have been studied, while the body-centred cubic and hexagonal close-packed structures are embrittled at some temperature. The austenitic stainless steels have a face-centred cubic structure and retain their toughness down to temperatures approaching absolute zero. It should be pointed out, however, that the presence of sigma-phase or precipitation-hardening constituents makes these steels partially unstable and may cause brittleness. For optimum results, low-carbon austenitic steels, quenched to retain the carbides in solution, are desirable. For economic reasons, the ferritic steels must be used in many applications. These, having the body-centred cubic structure, are sensitive to embrittlement at some temperature.

Melting practice has a considerable effect on the embrittling temperature. In the ferritic steels, thoroughly killed steels containing residual aluminium have the lowest transition temperatures while ordinary Bessemer steels have the highest. Between these two extremes, in order of decreasing toughness, are the semi-killed steels with aluminium additions, the silicon-killed steels, and the rimmed steels.

The effect of composition has not been fully established. In ordinary carbon steels, low carbon content favours low transition temperatures, but the quantity of carbon present may be less important than its distribution: a fully dispersed form of iron carbide is less damaging. Phosphorus and sulphur should be held as low as possible, but manganese, up to 1½%, appears to lower the transition temperature. Beyond that quantity manganese can be harmful, particularly in steels which are sensitive to temper brittleness. Silicon up to about 0·25% appears to be beneficial, although high silicon seems to be detrimental in both carbon and low-alloy constructional steels.

A number of investigators have shown that fine grained steels have lower transition temperature than coarse grained steels at any strength level. It has been indicated, however, that the over-heating of steel, even though the grain size has not been appreciably altered in appearance, can cause a precipitous drop in impact strength at low temperatures.

For the ferritic steels, fully hardened and tempered martensitic structures have the lowest transition temperatures. To avoid temper brittleness, the steels should be water quenched from the highest tempering temperature which will yield the required strength. The next most favourable structure is obtained by normalising and tempering. Slowly cooled steels containing lamellar pearlite have the highest transition temperatures of the heat treated steels. Steels in the as-rolled condition have shown erratic behaviour.

No specific recommendations can be made under the present state of knowledge for low temperature service. Selection depends on the stress distribution, strain rate and temperature range to be considered. However, some suggestions are possible.

For service in the range from room temperature to −25° F., ordinary carbon steels should be suitable, bearing in mind that, other things being equal, low carbon steels have the lowest embrittling temperatures. At the lower end of the range, under severe service conditions, fully killed steels containing residual aluminium might be required, since these steels have lower transition temperatures than the semi-killed steels.

For service in the range −25 to −100° F., low carbon-low alloy steels can be used. Steels sensitive to temper brittleness should be avoided; these include some of the manganese and chromium steels. The nickel, chromium-molybdenum, chromium-nickel-copper and nickel-chromium-molybdenum steels are suitable for application in this range.

Steels for service in the range from −100 to −200° F. are more limited. Of the ferritic materials, the nickel steels (particularly that containing 8½% nickel), chromium-nickel-copper, nickel-molybdenum, and chromium-molybdenum steels can be used, but they must be well-made clean steels and should be used, preferably, in the tempered martensitic condition. In this range most of the austenitic stainless steels are applicable.

Although certain of the nickel steels, particularly that containing 8½% nickel, can be used with caution below −200° F., this field is generally reserved for the austenitic steels. If the constituents are adjusted to obtain a stable, low-carbon alloy, the resistance to impact is excellent down to the lowest temperatures which have been investigated.

From *Materials and Methods*, **35**, 1952, 75-79.

Shielded Inert-Gas Metal Arc Process Successfully Welds Carbon Steels

By H. T. Horbst and T. McEbrath, Jnr.

SUCCESSFUL welding of carbon steels by the shielded inert-gas-metal arc process ("sigma" welding) is now possible with the use of a new argon-oxygen gas mixture. This mixture, containing approximately 5% oxygen and 95% argon, permits welding at high speeds without undercutting, improves coalescence of the weld metal at increased welding speeds, and provides good stability and low spatter rate.

The significant factor in adding oxygen to argon in the welding of carbon steel is the increase of rate at which drops of metal are discharged from the end of the welding electrode. This drop rate is in the neighbourhood of 30 to 50 times higher in the argon-oxygen mixture than in the pure gas atmosphere, as determined by means of high-speed motion picture photography.

Practical effects of these changes are claimed to be:—

(1) Much lower currents can be employed for a given size of electrode. This effect allows the use of much lower current densities and the selection of welding rods one or two sizes larger than is possible when using pure argon.

(2) Welding speeds are at least twice as high without encountering lack of coalescence, undercutting or porosity. For instance, in an argon atmosphere, lack of coalescence occurs when welding ¼ in. steel plate at 20 in./min., thus restricting the speed to about 15 in./min. With the argon-oxygen mixture, speeds up to 30 in./min. produce good welds.

(3) Straight-polarity direct current welding is usable. In pure argon, straight-polarity current is practically unusable, but with argon-oxygen mixture, satisfactory results have been achieved where minimum dilution and less are blow are desired.

Plate thicknesses of from $\frac{3}{16}$ in. to $\frac{3}{4}$ in. should generally be satisfactory for operation with the "sigma" process using bevelled edges, while for heavier plates "U" grooves may offer economy through decreased weld metal requirements. "Sigma" welding is applicable to low-alloy steels in these ranges of thickness. Killed or semi-killed materials are readily handled by the process, but porosity may be a factor in rimmed-type steels. As with other methods, laminated steels are more difficult to handle and will produce more porosity than sound plate.

For low-carbon steels, that is less than 0·10% carbon, a weld with approximately the same carbon content will be obtained using rod of substantially the same composition. Where the carbon content of the rod is in the neighbourhood of 0·30%, there may be a 15 to 20% loss of carbon in transfer across the arc; therefore, where heat-treating requires maintaining in the weld metal the same carbon content as in the base metal, the rod should have more carbon than is required in the weld.

Mechanical properties of "sigma" welds in steel depend principally on the rod composition and secondarily on the plate joint preparation. A low-carbon rod with manganese, and of the killed type, produces, in ¾ in. plate, welds having tensile strengths in the range of from 64,000 to 71,000 lb./sq. in. The lower figures occur with 70° welding vees and lower current values, while a 50° vee and high currents produce higher tensile values. Higher strengths suitable for low-alloy steels are obtained with a rod similar to the above but having some chromium as an alloy.

From *Materials and Methods*, **35**, 1952, 86–87.

Chip Formation Research Reveals Major Causes of Tool Wear

RESEARCH conducted at the Cincinnati Milling Machine Co., Cincinnati, Ohio, has revealed details of how chip formation and the action of lubricants can determine the service life of cutting tools and the surface quality of the workpiece. The findings of the research staff who carried out this research are of considerable economic significance, especially to large manufacturing firms where a reduction in tool wear would effect a substantial lowering of production costs.

Much of the information regarding the physical principles involved in the cutting of metals was obtained through photographic technique. The studies showed that the cutting process is one of shear and that the process of chip formation is one of plastic deformation. The ease with which a metal may be cut depends upon its shear strength. Best surface finish is obtained by forming a continuous chip without built-up edge. Next best is the discontinuous or segmental chip. The other category of chip is the continuous one with built-up edge.

Another variable that has received considerable study is that of the friction between tool and chip, and this record shows that one important consideration is the shear angle. The study of tool wear between grinds was conducted along four lines: the abrasiveness of the metal being machined, the power consumed in removing metal, the strength of the tool, and its heat conducting ability. Two conditions arise: inherent hardness of the metal being machined, and work hardening that accompanies plastic deformation at the time the chip is formed.

Research into lubricants showed that one with good friction reducing characteristics is of considerable value at low cutting speeds. However, at speeds of about 400 ft./min. there is practically no time to form the reaction products of a solid film nature at the chip-tool interface, to reduce the friction at this point.

The research raises many other points, such as analysis of heat produced during the machining operation. In brief, however, it was deduced that, by obtaining the optimum shear angle, by reducing friction at the point of contact between the tool and the chip, and by using lubricants of the desired chemical properties, power consumption could be lowered, work surface improved, and tool life increased.

From *Metal Progress*, Nov., 1951.

LABORATORY METHODS

MECHANICAL · CHEMICAL · PHYSICAL · METALLOGRAPHIC
INSTRUMENTS AND MATERIALS

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The British Industries Fair at Olympia

Laboratory Equipment Displayed

Although on a smaller scale than formerly, a display of laboratory equipment and scientific instruments will be a feature of the Olympia section of the British Industries Fair which will be held this year from May 5th to 16th. A brief account of some of the exhibits which are likely to be of interest to readers is presented in the following pages.

THE last decade has seen a considerable increase in scientific research and routine control for which a variety of items of laboratory equipment have been devised with a view to increasing the efficiency of the available scientific manpower. Although on a smaller scale than formerly, a number of items of scientific apparatus and laboratory equipment will be exhibited at the Olympia section of the British Industries Fair which opens on May 5th and continues until May 16th. In the following pages, brief details are presented of some of the exhibits likely to prove of interest to readers. Unless otherwise stated, the stands are on the ground floor at Olympia.

C. Baker of Holborn, Ltd.—Stand B.39

A comprehensive display of binocular and monocular microscopes and accessories, ranging from the simple-to-operate Students' Biolux Microscope to the new Wide Field Greenough Binocular Microscope, incorporating built-in illumination and many other outstanding features will be seen on this stand. Also on show will be the four-purpose Projectolux which can be fitted to any standard microscope for use as a microscope illuminator, as a micro-projector, for photo-micrography, and for image outline tracing, whilst among a variety of measurement and inspection instruments will be the Vernier Inspection Microscope which gives a vernier reading to 0·02 mm. over a distance up to 200 mm. Among the accessories, the Baker Phase Contrast Outfits, which make possible the examination of living unstained material, will no doubt attract considerable attention, opening up as they do new fields in research unattainable under ordinary microscopy.

Baldwin Instrument Co., Ltd.—Stand B.20

A number of thickness or weight gauges will be shown on this stand, and will include the "Atomat" Beta-Ray instrument which measures weight per unit area of sheet materials such as paper, cardboard, plastic, rubber and metal foil by the absorption of beta radiation. Sensitivity to light-weight materials has been improved and the range extended to heavier materials by the use of newly available materials. The Beta-Ray Back-scatter Thickness Gauge measures weight per unit area of material having an appreciably different atomic number from that of its backing, such as tin on steel, whilst the Gamma-Ray Thickness Gauge measures the thickness of metal from $\frac{1}{16}$ in. up to several inches by absorption of gamma-radiation. The detector is a scintillation counter calibrated in thickness for any given metal. The space between source and detector is large and the apparatus is rugged enough for hot rolling mill use. Amongst other exhibits on the stand will be a Baldwin-Farmer Sub-Standard X-Ray Dosemeter for measuring the output of X-ray tubes, a Protection Electrometer which serves to measure the stray radiation dosage received by operating personnel in radiography departments, and a Gamma Radiation Detector which has been improved by the addition of a halogen-quenched Geiger tube.

Courtesy of Cygnet Joinery, Ltd.

Laboratory furnished with Cygnet fittings

The British Rototherm Co., Ltd.—Stand B.16

The exhibits will include a comprehensive range of bi-metallic dial type thermometers and mercury-in-steel thermometers. The former are suitable for temperatures from − 100° F. to + 1,000° F., and the latter from − 35° F. to + 1,200° F. Both types can be fitted with contact heads to provide on/off control when used in conjunction with a suitable relay. An electronic relay

will also be featured, suitable for loads up to 20 amps. 230 volts A.C. Also exhibited will be two mercury-in-steel indicating temperature controllers, suitable for use in a temperature range — 30° F. to + 1,100° F., with a minimum coverage of 50° F. They can be fitted with minimum and maximum contacts arranged for on/off control, the differential being variable between full scale and a minimum of 1% of the scale range, or with a zero differential on/off control fitted with either maximum or minimum contacts, but not both. The 10-in. diameter mercury-in-steel chart recorder will also be shown. This can be arranged to rotate in 12-hour, 24-hour, or seven-day cycles. Of special interest will be two types of small portable recorders using 6-in. diameter charts, one actuated by bi-metal helix and the other operated on the mercury-in-steel principle. There will also be displayed a range of light industrial instruments where the robustness found in the heavy industrial type is not essential. Centigrade scales can be fitted to any of these instruments.

*Cygnet Joinery, Ltd.—Stand B.*19

The Cygnet range of laboratory furniture on show this year will contain a number of novel features. The standardisation of units has been extended to include all requirements of the modern laboratory. Island benches, wall benches, apparatus cupboards and reagent shelves, etc., can be built up from standard units and can, after installation, be changed about to suit alteration of policy and function without touching the main structure of the furniture. Bench tops are in Iroko, braced with steel in a unique manner to inhibit splitting and warping, and a special sealer is used which has a number of advantages over linseed oil. For waste disposal, a foot-operated compartment is provided. The floor of the standard is made of the famous interlocking "Panel Parquetry" wood block floor for which the exhibitors are licensed manufacturing agents. This floor is in the same acid-resisting timber as the bench tops.

*Glass Developments, Ltd.—Stand B.*28

The principal exhibit will be the latest version of the Ultrasonic Flaw Detector in which a picture similar to an X-ray radiograph of a specimen, is shown on a cathode-ray tube screen. It can be used to detect internal flaws (e.g. cracks, blowholes, porosity, etc.), in either ferrous or non-ferrous metals and some other materials. The principle of operation is that sound waves are projected into the material and echoes obtained from any flaws are picked up, amplified and displayed on a cathode-ray tube. The sound waves are transmitted and received by quartz crystals mounted in probes, and as the probes are moved along the surface of the specimen under test a picture is painted in on the screen of the cathode-ray tube, showing any flaws. In this way, a picture of a section through the specimen is seen, and the instrument can be used to inspect up to 20 ft. thickness in metal. The instrument is portable (weight 40 lb.) and can be used to inspect ingots, billets, forgings, castings, etc. It can be regarded as being complementary to X-ray equipment, particularly since the inspection can be done rapidly. It is particularly useful for the inspection of welds in pressure vessels and pipe work.

*Imperial Chemical Industries, Ltd.—Stand C.*14

The Technical Service provided for customers by Imperial Chemical Industries, Ltd., is the theme of the company's Main Stand at Olympia. Three-dimensional models are used to illustrate the story of how I.C.I.'s Technical Service men put the company's great technical and research resources at the disposal of customers in all parts of the world. This service has evolved from the fact that nearly all I.C.I.'s products are the raw materials of other industries, and the company believes that its responsibility does not end until a product is functioning correctly in the hands of the customer. To achieve this object, Technical Service men work in close

Courtesy of Baldwin Instrument Co., Ltd.

Protective electrometer

Courtesy of Johnson, Matthey & Co., Ltd.

A selection of precision castings in silver and bronze

collaboration with the company's Selling Organisation in every part of the world where I.C.I. is represented.

*Johnson, Matthey & Co., Ltd.—Stand J.*107

As was the case last year, emphasis in designing their exhibit in the jewellery section is primarily upon providing a convenient and comfortable meeting place for their many friends in the trade, where problems and developments may be discussed, rather than upon display in the conventional sense. The stand will contain, however, a composite exhibit covering not only their activities in providing materials for the jewellery and allied trades but the many sections of industry in which the noble metals are of such significance to-day.

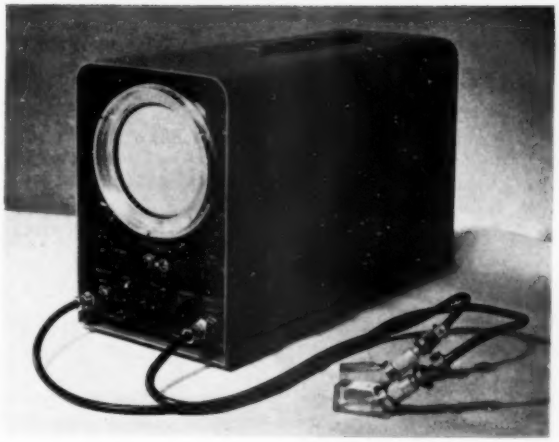
Of special interest will be examples of their latest service to the craftsman, precision castings in silver and in carat gold alloys. These high fidelity castings, produced by a development of the widely known lost wax process, can be manufactured in quantity from a single master. Finishing work is much reduced, and the method permits the reproduction of articles of most complex shape.

*The Tintometer, Ltd.—Stand B.*13

The main exhibits on The Tintometer Stand will include the Lovibond Tintometer (B.D.H. pattern), the Lovibond Schofield Tintometer and the All Purposes and Pocket Type Lovibond Comparators, together with a number of accessories for these, such as fused glass cells, artificial white light equipment and a spinning device for measuring unevenly coloured samples. Among the new exhibits will be an addition to their range of books on colour, "The C.I.E. International Colour System Explained," by G. J. Chamberlain, which is a simple explanation of the International System for the description of colour, written for the non-technical reader and showing its value for colour specification in industry. Other new items will include a small instrument for grading the colour of solids against a restricted range of pre-arranged standards, and a new type of comparator which can be used to test the colour of water white liquids. This operates on the same principle as the ordinary comparator, but a 12 in. depth of liquid enables minute differences in colour to be distinguished. Another piece of apparatus which has the Lovibond Comparator for its basis, is the new Turbidity Tester which is used for testing turbid solutions which are also coloured.

*J. W. Towers & Co., Ltd.—Stand B.*45

This firm, who are suppliers of all types of laboratory equipment, will be showing a wide range of their products. The balances on show will include the Model 200 Automatic Direct Reading Balance which is a single pan constant load type with a capacity of 200 g. and sensitivity of 0·1 mg. For weighing heavier samples in the laboratory, the Towers Sliding Weight Balance, Model 5, with a capacity of 2 kg. and sensitivity of 0·1 g., and the new Towers Model 7 Rotating Weight Balance, with a capacity of 6 kg. and sensitivity of 0·5 g., which have found great popularity as they eliminate the use of small weights, will be exhibited. For heating purposes, there will be a display of a Towers Universal Electric Ovens which are fitted with thermostatic control, and suitable for temperatures up to 200° or 300° C. according to the model, together with electric muffle furnaces made in a wide range of sizes and suitable for temperatures up to 1,000° C. Other exhibits will include chemical glassware,



Courtesy of Glass Developments, Ltd.

Ultrasonic flaw detector.

Lablox support frames for the mounting of complicated and special apparatus, the Towers Apparatus Drier which provides a rapid means of drying miscellaneous items of glassware which are in constant use, and the Towers Vibro Shaker which operates on the principle of high-frequency vibration and provides a simple means of shaking vigorously and efficiently small quantities of liquids in any convenient type of container such as test tubes, flasks, etc.

*Taylor Electrical Instruments, Ltd.—Stand B.*15

Included in the instruments made by this Company, many of which will be displayed on the stand, are valve voltmeters, capacity resistance bridges, circuit analysers, valve testers, television pattern generators, television wobbulators, signal generators, audio-oscillators, cathode ray oscillographs, insulator testers, output meters, and a number of universal multi-range meters. Of particular interest will be a new range of Universal Multi-range Meters which have been developed with a view to being equally suitable for the North and South American markets as for use in this country. The Model 72A has 19 ranges and British Standard first grade accuracy on all the ranges which cover 0–750 volts (A.C. and D.C.), 0–15 amps (A.C. and D.C.), and 1 ohm to 500 kilohms. Model 71A has almost the same ranges but an accuracy 2% of full scale on D.C. ranges and 4% on A.C. ranges. The Model 77A has an accuracy of 2% of full scale on D.C. ranges (except 3 kV.), 4% on A.C. ranges and 3% on the 3 kV. range. The 19 ranges cover 0–3,000 volts D.C., 0–750 volts A.C., 0–15 amps. D.C., and 10 ohms to 5 megohms. All these models have a buzzer for continuity testing and output as A.C. volt ranges via a condenser. The Model 88A has an accuracy of 2% of full scale on all the D.C. ranges but the 5 kV. range, 4% on A.C. range, and 6% on the 5 kV. range. The 74 ranges cover 0–5,000 volts (A.C. and D.C.), 0–10 amps. (A.C. and D.C.), 1 ohm to 5 megohms, − 34 to + 55 decibels, 0·2–200 henrys, and 1,000 pF to 100 mF, the last two by the use of external adaptors. A buzzer is provided for continuity testing. This model carries a decibel range with a reference level of 6 mW. in 500 ohms which is standard British practice or, as an alternative, a reference level of 1 mW. in 600 ohms which is standard U.S. practice.

Investigations on Colorimetric Methods of Metallurgical Analysis

Part V.—Details of Duplicate Colour Standards for the Determination of Molybdenum in Alloy Steels

By G. V. L. N. Murty., M.Sc., F.R.I.C.; D.Sc., F.A.Sc. and S. Jaya Rao, M.Sc., A.R.I.C.

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Details are given of the preparation of permanent duplicate colour standards for the visual colorimetric estimation of molybdenum in alloy steels by the standard series method. It is shown that these standards, which are easily prepared, can be used satisfactorily over long periods.

A SIMPLE visual colorimetric procedure (standard series method), based on Vaughan's investigations,[1] has recently been devised by one of the authors[2] for the estimation of molybdenum in alloy steels. The colour involved in this procedure could not be rendered stable for more than eight hours, thus necessitating the development of standard tints at least once during that period. Accordingly, an exploration was made of the possibilities of preparing duplicates of these colours by suitable mixtures of solutions of judiciously selected inorganic substances. As a result of these experiments it was found that colour standards could be obtained by mixing potassium dichromate and cobalt nitrate solutions.[3] In the early stages, they were obtained by carefully mixing previously prepared solutions of the salts so that they corresponded to the respective tints of the standard synthetic steel solutions when developed in the usual manner.[2] Experience has shown the desirability of replacing the trial and error procedure for the duplication of tints by a more systematic one, whereby it would be possible to mix fixed quantities of the respective solutions and water in each case. The satisfactory results which have attended efforts to this end will be evident from the following sections.

Procedure

A number of experiments were carried out to determine the required amounts of the standard solutions of the two salts for each particular molybdenum content, and the final figures were arrived at by confirming visual judgments with absorptiometric investigations carried out with the Spekker photoelectric absorptiometer. The respective drum differences, obtained with the duplicate standards and the coloured solutions as developed by the usual procedure from the corresponding synthetic steel solutions, are recorded in Table I, from which the satisfactory nature of the duplication can be seen. Once the quantities are fixed the procedure is very simple, although it appears desirable, in each case, to check up the final solution absorptiometrically before filling the test tube for sealing.

Preparation of Stock Solution

(i) *Potassium Dichromate Solution.*—A.R. quality potassium dichromate is finely powdered and dried so as to free it completely from moisture. One stock solution (*A*) is prepared containing 1·0% of the salt, and another (*B*) containing 0·1% is obtained by diluting (*A*). The stock solution (*B*) is used for duplicating standards up to 0·25% molybdenum, beyond which solution (*A*) is needed.

(ii) *Cobalt Nitrate Solution.*—Since cobalt nitrate cannot be obtained in the solid state with a uniform degree of purity and moisture content, it is necessary to start with a slightly stronger solution than is finally required. After carrying out an accurate determination of the cobalt content of this solution, by an electrolytic or gravimetric estimation, it is suitably diluted to yield stock solutions (*C*) and (*D*), containing 1·0% and 1·22% cobalt, respectively. Stock solution (*D*) is only required for duplicating the standard containing 0·6% molybdenum, solution (*C*) serving the purpose in all other cases of lower molybdenum content.

TABLE I

Mo %	Potassium Dichromate Solution—ml.	Cobalt Nitrate Solution—ml.	Drum Difference of the Duplicate Colour Standards.	Drum Difference of the Synthetic Steel as Developed by the Usual Method.
0·05	5·0 (*B*)	6·5 (*C*)	10·3	10·5
0·10	8·0 „	10·5 „	16·1	16·0
0·15	10·0 „	14·0 „	21·5	22·0
0·20	11·0 „	19·0 „	27·2	27·2
0·25	12·0 „	21·5 „	32·0	32·0
0·30	1·3 (*A*)	27·5 „	38·0	38·0
0·35	1·5 „	31·5 „	42·5	42·8
0·40	1·8 „	38·0 „	46·5	47·0
0·45	1·8 „	43·5 „	52·5	53·5
0·50	1·8 „	47·5 „	56·2	56·1
0·55	2·0 „	48·0 „	60·5	61·5
0·60	2·0 „	48·0 (*D*)	65·8	65·8

TABLE II

Mo %	Mo % by the Usual Procedure.	Mo % Using Duplicate Standards		
		Freshly Made	3 Months Old	6 Months Old
0·11	0·11	0·10	0·10	0·10
0·19	0·19	0·18	0·18	0·18
0·24	0·24	0·24	0·24	0·24
0·28	0·28	0·28	0·28	0·28
0·41	0·41	0·39	0·41	0·39
0·46	0·46	0·44	0·45	0·44
0·53	0·53	0·51	0·52	0·52
0·60	0·60	0·58	0·60	0·59

Preparation of Duplicate Colour Standards

The duplicate colour standards are prepared by mixing accurately measured quantities of the respective stock

1 Vaughan, The Institute of Chemistry Lecture on "The Use of the Spekker Photo-electric Absorptiometer in Metallurgical Analysis," 1941, pp. 17–18.
2 Murty, *Proc. Ind. Sc. Cong.*, 1946, and *Metallurgia*, 1947, **35**, p. 167.
3 Murty, *Metallurgia*, 1947, **36**, 345.

solutions and making up the volume in each case to 50 ml. with distilled water. They are then checked by absorptiometric comparison with the corresponding coloured solutions of synthetic steels, as developed by the usual procedure. For increasing the stability of all the solutions, as well as the duplicate colour standards, it is considered desirable to use water which has been redistilled over potassium permanganate. The test tubes—all of uniform diameter—are thoroughly cleaned and dried and, after being filled with the respective standards, are neatly sealed and labelled. Spare tubes of the same diameter may be kept along with these in a suitable cabinet for convenience. Table I gives details of the relative quantities of the respective stock solutions used to obtain the duplicate colour standards in the range 0·05–0·6% molybdenum.

These standards are found to be very convenient, and have been used in the authors' laboratory for over six months. The percentage molybdenum determined in some typical steel solutions by effecting comparisons with the usual standards, and with the duplicate standards of different ages, are recorded in Table II. It will readily be seen from these results that the duplicate colour standards are very satisfactory and can be used satisfactorily up to at least six months after their preparation.

Acknowledgments

The authors' thanks are due to the management of the Tata Iron and Steel Co., Ltd., for permitting the publication of this paper, and to the Director of Scientific Services and the Chief Chemist, Tisco, Ltd., for their keen interest in the work.

Progress in Hardness and Micro-Hardness Testing in 1951

THE hardness of metals and the means of measurement of this property continue to attract a good deal of attention and in the following account, based on a section of "The Diamond Tool Industry in 1951,"* brief reference is made to developments and research work reported during 1951.

A valuable addition to the literature of the subject took the form of a book by Tabor,[1] "The Hardness of Metals," which is one of a series of monographs on the physics and chemistry of materials. No attempt is made to describe in detail the practical techniques involved in hardness measurements, rather is the aim to explain hardness measurements in terms of some of the more basic physical properties of metals. It does not deal with the atomic and crystalline mechanism of elastic or plastic deformation, but starting with the assumption that metals possess certain elastic and plastic characteristics it shows that the hardness of metals may be expressed in terms of these characteristics.

The problems and difficulties associated with micro-hardness testing, using a light-load Bergsman apparatus, were discussed in a number of papers, including those of Hundy[2] and Bergsman.[3] These difficulties led Grodzinski to develop a light-load Bergsman-type hardness tester in which the human element is eliminated by automatic electrical control.[4] The factors influencing micro-hardness values were also discussed by Russian investigators[5] who suggested as possible reasons for the dependance of micro-hardness values on the applied load: inaccurate operation of the tester; the peculiarities of single crystals; the effect of varying grain strength; non-uniformity in the structure of the metal; and general changes in the test piece, either at or just below the surface. Cracks occurring during micro-hardness testing were also discussed: Grodzinski contended that, as the hardness test involved plastic deformation, damaged impressions should be avoided.[6] Attention was drawn by Meincke[7] to the use of indenters which indicate direction. This enables varying hardness values to be found in materials according to whether the indenter is placed parallel to the rolling direction or normal to it. For these investigations a chisel-edged diamond was used, but reference was also made to the Knoop and Double Cone diamonds. New definitions for Brinell hardness based on the Hertz formulae were developed by Kappler[8], whilst Grodzinski[9] advanced a new hardness definition, based on the Meyer straight line law, which has been proved satisfactory for a large number of materials and different shapes of indenter. The accuracy of measurement of the indentation in micro-hardness testing was discussed by a number of workers, and Bergsman[3] suggested the calibration of the microscope by means of diffraction gratings; in Russia, the electron microscope has been used for accurate measurement of the indentations.[10] Comparison tests by a number of workers, using various micro-hardness testers, were reported in an experimental survey of low-load hardness testing instruments by Brown and Ineson[11]. It was concluded that the absolute low-load hardness values obtained varied considerably because of the large number of uncontrolled variables.

During the year, a number of new hardness testing machines were described[12]. A thorough investigation was made on the accuracy of the Austrian Emcotest hardness tester[13] and the production of the portable American Ames hardness tester described in detail,[14] whilst for micro-hardness testing S. J. Lloyd and D. J. Norris[15] gave details of an improved instrument for use with the Vickers projection microscope. In Holland, the TNO Institute for Applied Science has developed a micro-hardness tester for plastic materials[16] in which the penetration of the diamond is measured electrically. The test load is normally 5–20g. but it can be raised to 75g. Hardness measurements are made by plotting penetration against time: a penetration of 15–20 micron is made, the accuracy being one micron or better. A micro-hardness tester with a projection device, called the "Micro-testor" has been developed by Wolpert Werke,[17] whilst in Russia, E. S. Berkovich[18] has developed a dynamometer for calibrating the loading device of micro-hardness testers. An automatic hardness tester with 40 s.p.m. was developed in the U.S.A.[19]

Increased attention was devoted to the hot testing of aircraft materials during the year under review, and improved devices were described by H. S. Avery[20] and A Brenner.[21] In the latter apparatus, which measures the hardness of electrodeposited coatings at temperatures up to 900° C. in an inert atmosphere, the indenter is fixed to a special mounting.

The influence of the shape of the Rockwell indenter was the subject of a thorough investigation[22] at the National Physical Laboratory. Rockwell indenters

* Published by the Industrial Diamond Information Bureau.

with varied radii and angles, specially made for the purpose, were assessed by means of the new dead-load testing machine. Grodzinski[23] pointed out that satisfactory interferograms of a Rockwell point were not shown in these investigations and demonstrated a Rockwell cone of better shape, produced by a special method. Changes in the form of the standard Rockwell indenter were also put forward in Germany by Boeklen,[24] who, with the object of obtaining a better correlation with Brinell hardness values, suggested a diamond cone of 140° included angle instead of the standard 120° angle cone. The Double Cone diamond was used for testing silicon carbide, sintered carbide and high speed steel,[25] whilst a triangular diamond pyramid was suggested by Berkovich[26] for testing diamond. A similar pyramid was made in England and also tested on diamond, but the results were not so successful as those reported from Russia. Tests on electro-polished copper showed that the triangular pyramid was not superior to the square-based pyramid.[27]

A wide range of materials formed the subject of micro-hardness testing investigations during the year. Mitsche and Onitsch[28], for instance, carried out extensive experiments on minerals, using a square-based diamond pyramid on the Reichert micro-hardness tester. In Russia the micro-hardness test was announced as a new method for testing minerals,[29] whilst in America the Knoop diamond, on the Kentron micro-hardness tester, was used as a quantitative means for identifying opaque minerals.[30] Dalton[31] reported on the micro-hardness testing of meteorites, and the directional properties of silicon carbide crystals were investigated by means of the Double Cone diamond,[32] whilst a large series of sintered carbides was tested by Koval'skii and Kanova.[33] A novel suggestion by Pemberton[34] concerned a new method of testing the hardness and toughness of abrasives by exposing individual crystals of some 0·3mm. size to a static load or to impact. Interesting results were obtained with a large number of abrasives.

In a number of investigations, the correlation between hardness and other properties was studied. Russian workers[35] attempted to elucidate the mechanism of grinding and polishing by micro-hardness testing, whilst Longard[36] showed the influence of mechanical and electrolytic polishing of metals including pure aluminium, duralumin, Armco iron and steel. The relationship between Mohs scale and micro-hardness was discussed by Khrushchov[37] and the fundamental connection between the various hardness tests by Ludwig[38], whilst Tabor[39] reviewed existing opinions on the relationship between the strength and hardness of metals. On the practical side, a summary of the different workshop methods used in hardness testing was given[40] and the tolerances for practical hardness testing were shown by Riebensahm.[41] A German testing station equipped with a new dead-load Rockwell hardness tester now undertakes to calibrate testing plates and indenters for a fee.[42]

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Elected Fellows of the Royal Society

Among the twenty-five scientists recently elected into the Fellowship of the Royal Society are the following:—

Sir Wallace A. Akers, C.B.E., Director, Imperial Chemical Industries, Ltd.; C. E. H. Bawn, Grant-Brunner Professor of Inorganic and Physical Chemistry, Liverpool University; F. J. Dyson, Associate Professor of Theoretical Physics at the Floyd Neuman Laboratory of Nuclear Studies, Cornell University, Ithaca, N.Y., U.S.A.; D. L. Hammick, Aldrichian Praelector in Chemistry, Oxford University; L. Hawkes, Professor of Geology, Bedford College, London University; H. Jones, Professor of Mathematics, Imperial College of Science and Technology, London University; W. H. McCrea, Professor of Mathematics in the University of London; A. C. Offord, Professor of Mathematics, Birkbeck College, London; A. G. Pugsley, O.B.E., Professor of Civil Engineering, Bristol University; M. Ryle, Lecturer in Physics, Cambridge University; D. M. Smith, Chief Engineer, Gas Turbine Department, Metropolitan-Vickers Electrical Co., Ltd.; F. S. Spring, Professor of Organic Chemistry in the Royal Technical College, Glasgow; E. W. Taylor, C.B.E., Joint Managing Director of Cooke, Troughton and Simms, Ltd.; S. Tolansky, Professor of Physics, Royal Holloway College, University of London; T. S. Westoll, Professor of Geology in the University of Durham.

Correction

Polarographic Determination of Chromium in Certain Aluminium Alloys

We are advised by the authors of the above article, which appeared in our December issue, of an error in the manuscript: the suppressing and deoxygenating solution was described as containing sodium sulphate instead of sodium sulphite. The error occurs in the first column of page 330, under the heading "Solutions Required." The second line of (6) should read:—

15 g. of hydrated sodium sulphite in water,

Quantitative Printing Methods for the Study of Segregation in Steel

By Hugh O'Neill, D.Sc., M.Met., F.I.M.

A trial is described to determine quantitatively the degree of sulphide segregation in a steel, by the photometry of transparent sulphur prints. The principle could be extended to phosphorus prints on cellophane. Manganese and chromium printing should also be possible.

ALL metallurgists concerned with steel have learned to appreciate the value of the Baumann sulphur print as a means of observing segregation. In fact, it was Mr. Harry Brearley, I believe, who once said that if there were no sulphur in steel, we might have to introduce it in order to study segregation effects. The brown stain left on the acidulated silver bromide photographic paper has been said to exaggerate the sulphur concentrations, but at least it enables one to see not only any regions of high sulphur, but also to estimate the average content of that element. Such estimations are only valid if phosphorus plays no part in the printing, and whilst some claim that it does, the opposite view is held by M. Niessner.[1] Heyn and Bauer have shown that cloth soaked in acid mercuric chloride develops black stains at sulphur segregates and yellow marks at phosphorus concentrations. Their technique was modified by Van Royen and Ammermann[2] so as to produce mercury prints of sulphur and phosphorus on gelatine paper, and the amounts of each element could presumably be estimated by visual judgment.

The determination of the actual sulphur value at points of concentration in Baumann prints is possible if phosphorus and other factors are constant, and photometric methods have been suggested for this purpose over a period of years. Such methods are less complicated than spectrometric surveys, and more precise than procedures involving drilling and chemical analysis.

Transparent Sulphur Prints

One or two points must not be overlooked in connection with sulphur prints. Metallic arc weld deposits of steel containing, e.g., 0·043% S will give a much paler print than steel plate containing, say, 0·042% S. It has been proved by X-ray examination that the sulphur is present as sulphide of manganese in both cases. Microscopic examination of the prints revealed small particles, the macroscopic effect of which is paler than normal. Oxyacetylene weld deposits give the normal effects for sulphur.[3] For standardisation purposes therefore, the sulphide particle size should be constant and this probably means that, for a given test piece, its standards should be from ingots manufactured in similar fashion and subjected to similar heat treatment. Furthermore, the presence of chromium hinders the printing, and this element—either as a residual or added constituent—must be allowed for.

TABLE I.—STANDARDISATION OF PHOTOMETER

Mean Sulphur Content %	Print A			Print B		
	Background of Paper (av.)	Print (av.)	Net E.M.F. (divs.)	Background of Paper (av.)	Print (av.)	Net E.M.F. (divs.)
0·205	0·05	0·43	0·38	0·05	0·43	0·38
0·076	0·02	0·13	0·11	0·075	0·16	0·085
0·042	0·02	0·095	0·075	0·060	0·155	0·095
0·024	0·055	0·100	0·045	0·045	0·085	0·04

In view of a renewed interest which has recently been expressed regarding simpler methods for studying segregation, the following trial which was made in 1946 seems worthy of publication.

The ordinary opaque single sulphur print is at a disadvantage when a large number of reproductions is required for multiple report purposes. During 1940[4] the present writer improved matters in this respect by making the prints on transparent "glossy Kentmere film paper." The master print was afterwards used for producing any required number of "reversed sulphur prints," in which regions of high sulphur stood out effectively as light streaks on a dark background. Ordinary celluloid photographic film can be utilised in the same way, but it is very slippery compared with Kentmere paper, and manipulation is therefore more tiresome. Unknown to the writer the difficulty had already been solved, for Baars, Prill and Werner[5] had previously employed "photo-mechanical bromide paper," and W. H. Dearden[6] described procedures in 1935 for using "stripping paper" or "strip film."

Standardisation of Photomicrometer for Sulphur

The production of commercial recording photomicrometers suggested that sulphur prints on transparent papers could be rapidly and easily scanned and evaluated so as to give quantitative surveys of segregation. Calibration of the photometer is necessary, and four different samples of steel were secured for this purpose. Small rectangular pieces from each were mounted side by side in the normal bakelite mounting press, and the four $\frac{3}{8} \times \frac{1}{8}$-in. surfaces were polished together. Sulphur prints under a standardised condition of acid and timing were next made from the assembly on Kentmere paper. The prints were then held in the glass plates of a Knorr-Albers Recording Photomicrometer, traversed by a photocell, and from the graphs the data given in Table I

1 Niessner, M., *Mikrochem.* 1930, **8**, 339 and 1932, **12**, 1.
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6 Dearden, W. H., *J. Iron and Steel Inst.* 1935, **1**, 297.

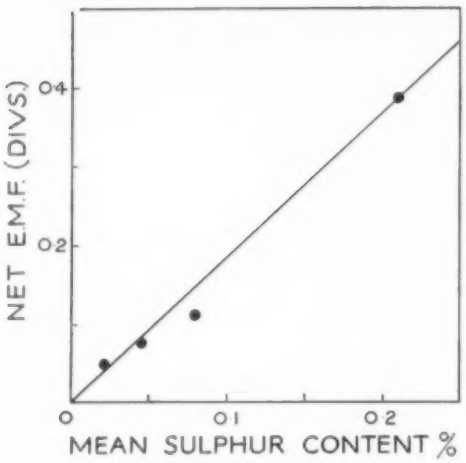

Fig. 1.—Calibration diagram.

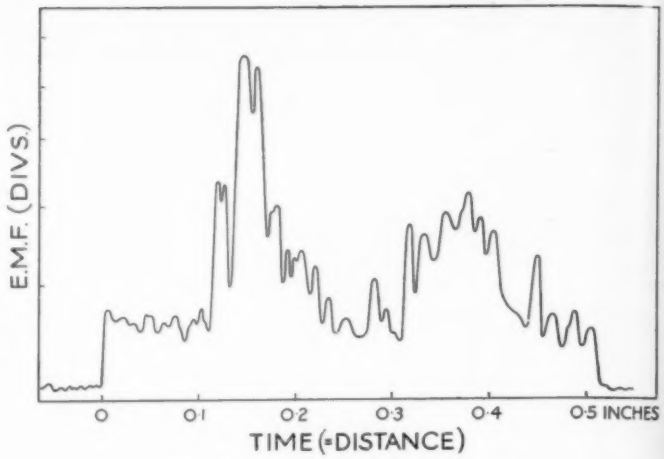

Fig. 2.—Record from sulphur print.

were obtained. The translucent Kentmere paper showed considerable variations in density, and the scatter of the graphs was averaged.

Visual examination of the print sufficed to show that the 0·076% S steel gave only about the same colour intensity as the one with 0·042% S. It was found to contain some distinct specks of sulphide, whilst the other three samples each had a uniform tint. Care must therefore be taken that the standards have about the same phosphorus contents, and as mentioned before their sulphur must be uniformly divided and distributed. It would doubtless be as well if their manganese contents were uniform, but no special precautions were taken in the present trial. The high sulphur steel was "Phoenix" Free Cutting containing 0·047% P and 0·88% Mn.

The photocell E.M.F. values from the logarithmic scale of the chart, plotted against sulphur content, gave the graph shown in Fig. 1. In the range examined it is almost linear, but a standard up to 0·5 or 1·0% sulphur should have been included, and the curve might then have turned upwards to some extent.

Tests on Web of Segregated Rail

The sulphur print of a segregated steel rail was then scanned at different speeds across the 0·5-in. width of the web. The results obtained after reference to the standardisation diagram are given in Table II. Trace 3 is believed to have given the best graph and is reproduced in Fig. 2. It was obtained with a 50-mm. lens on the light source and a 16-mm. one on the photocell.

According to these results, the highly segregated spots may approach ten times the sulphur content of the mean background. Segregates containing five times the minimum sulphur of a steel as determined by drilling and analysis are not uncommon, and it is therefore reasonable to find higher proportions by more refined methods.

TABLE II.—SULPHUR CONTENTS OF RAIL—PER CENT.

	Trace 1	Trace 2	Trace 3
Scanning Speed mm/min.	2·5	10	5
Main Background	0·043	0·043	0·043
Maximum of Dense Twin Peak* ..	0·47	0·50	0·45
Second Twin Peak	0·19	0·23	0·23

*From extrapolated standardisation graph.

Extension of the Principle to other Elements

In 1924 Canfield introduced a phosphorus print process, and another one was developed by Niessner in 1930.[1] Grubitsch and Warblicher[7] have described a technique by which the Niessner prints are produced on cellophane film 0·025 mm. thick. Nitric ammonium molybdate is applied so as to diffuse through the film, and if the print is developed in strongly hydrochloric stannous chloride solution then "molybdenum blue" is produced in the regions of phosphorus reaction. The process seems liable to interference from sulphur segregations, but if these are not serious the method should lend itself to photometric treatment with standards. Grubitsch[8] has also used cellophane for printing oxide type inclusions in steel.

Manganese segregation in ingots and in banded wrought steels should be capable of cellophane reproduction by reaction with strong oxidisers like persulphates. Concentrations of chromium might also lend themselves to printing techniques by oxidation processes.

Acknowledgment is made to Messrs. Hard Metal Tools, Ltd., for kindly making available their photomicrometer.

7 Grubitsch and Warblicher, *Arch. f.d. Eisenhütt*, 1942, **16**, 77.
8 Grubitsch, *Arch. f.d. Eisenhütt*, 1942, **16**, 79.

Alsheath Limited

BRITISH Insulated Callender's Cables, Ltd., and The Loewy Engineering Company, Ltd., have formed a new company to utilise their knowledge, patents and development work in the field of aluminium sheathed cables. The name of the new Company is ALSHEATH, LTD., and its offices are at Norfolk House, Norfolk Street, London, W.C.2. The experience of B.I.C.C. as cable makers and of Loewy Engineering as builders of extrusion presses will be incorporated in new plant for the cable making industry in the United Kingdom and for export.

Refractory Mouldings and Castings Ltd.

WE are advised by Refractory Mouldings & Castings, Ltd., that the telephone number and telegraphic address of the Company are now Kegworth 429 and Aremcee, Kegworth respectively.